Evaluation of Ice Alert®

Final Report

State Research Project
OR-95-16

by

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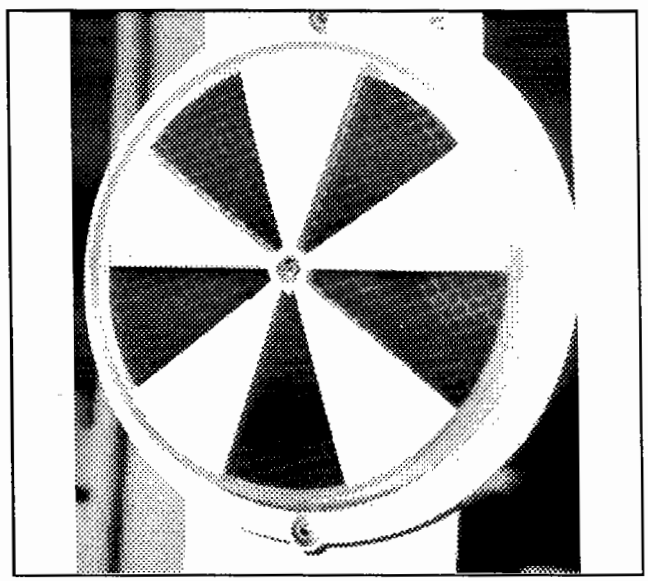


RESEARCH UNIT

Oregon Department of Transportation

March 1995

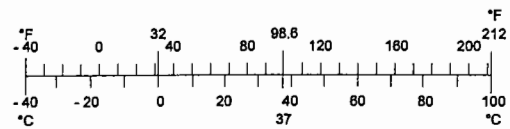
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

ACKNOWLEDGMENTS

The work presented in this report was conducted as a part of a project funded through the Oregon Department of Transportation (ODOT). The author is grateful for the support of the various districts and maintenance sections of ODOT for installing and monitoring the devices. Thanks also go to the Materials Unit for their assistance in the laboratory tests, Eric Brooks of the Research Unit for field data gathering, Sharon Thompson for the copy edit, and to the Department of Justice and Risk Management for their advice.

DISCLAIMER

EVALUATION OF ICE ALERT®

EXECUTIVE SUMMARY

BACKGROUND

One of the goals of road and highway agencies has been to reliably warn motorists of hazardous conditions, particularly the presence of ice on the road. To this end, in the late 1980s, Oregon State Highway Division, now the Oregon Department of Transportation (ODOT), was approached about a device called Ice Alert®. The device was described as a way to alert drivers to the possible presence of ice on the road. Because claims that this device would result in increased safety for motorists were based on anecdotal evidence and subjective opinion rather than objective data, ODOT management requested an evaluation of Ice Alert®.

EVALUATION CRITERIA

Ice Alert® devices were tested in the laboratory to determine their degree of reflectivity and their sensitivity to changes in temperature. They were then tested in the field in order to develop cost data, document maintenance problems, evaluate the siting criteria, and determine driver reactions to the devices.

When evaluating driver response to the devices, the hypothesis tested was: If motorists are aware of roadway conditions, they will respond with reduced speed and increased caution. This would lead to a reduction in ice-related accidents.

Driver response to the Ice Alerts® was determined through an independent survey of motorists in the test site areas, and on-site speed measurements.

FINDINGS

Laboratory tests: There were 131 Ice Alert® devices tested for reflectivity and temperature sensitivity.

- The devices met the reflectivity standards.
- Three devices failed tests for temperature sensitivity, for an overall failure rate of 2.4%.

Field tests: To test operational factors, the devices were installed at 20 sites for the winter of 1991 - 92 using the manufacturer's recommendations. The results were as follows:

- Costs for these installations, including paddles and steel posts, averaged $70.70 per installed reflector plus an additional $450 for the necessary signing. The total cost for the 1991-92 installation was about $55,000.

- There was a significant amount of theft and vandalism of the devices.

- In areas where snow plows were active, they were hard to keep clean.

- Because the devices measure air temperature, they can and do show white, even though there may still be ice present on the roadway.

- The manufacturer's siting criteria appeared to be adequate.

To test drivers' reactions to the devices, 340 motorists in the test site area were interviewed by phone, and actual speed measurements were taken at three sites. The results were as follows:

- Of 340 drivers interviewed, 59% (200) indicated that they were aware of the devices. These were the drivers who were selected for a complete interview.

- Only 53% (106) of those interviewed had driven the section when temperatures were below freezing.

- When asked about the appearance and function of the device, 79% (158) said it turns blue if the temperature is freezing or icy, and 26% (52) said it stays silver or white if not freezing or icy.

- Of the group that drove the section when temperatures were below freezing 57% (60) stated that they altered their driving behavior.

- Of those interviewed, 90% (179) said their driving behavior would be affected if they observed the devices showing blue. Of those who said they would change their behavior, 82% (145) said they would reduce speed.

- Of those interviewed, 74% (148) believed that the devices would be an effective means of warning drivers of potentially dangerous driving conditions

- The speed monitoring results showed the vehicles slowing a maximum of

2 mph when the Ice Alert® devices were blue. This number is not significant considering the speed measuring devices are accurate to +/- 1 mph.

- Speed monitoring tests showed an overall tendency for drivers to reduce speed when temperatures were below freezing that could not be directly connected to the presence of the Ice Alerts®.

CONCLUSIONS:

The devices did not cause a general slowing of traffic and, by implication did not reduce the potential for ice-related accidents.

The devices pose a significant liability issue defined as follows:

- Legal counsel has advised that, by installing the devices, the State warrants their accuracy, notwithstanding the fact that the manufacturer provides no warranty for performance or accuracy.

- The device only measures air temperatures. This means, due to the difference in pavement and air temperatures, the device can show white when ice is still present. Because 26% of the survey respondents perceived a white indication to mean the road is not freezing or icy, this presents a significant potential for tort claims.

- The device does not conform to the Manual on Uniform Traffic Control Devices (MUTCD).

The devices are subject to extensive theft and vandalism and require significant levels of on-going maintenance.

The results of surveys should be used with great care when the participants are asked to speculate on how they will modify their behavior in response to a warning device.

RECOMMENDATIONS

After consultation with legal counsel and risk management, the following was recommended:

- Discontinue general experimentation with the devices until the manufacturer can show improved accuracy.

- Any further experimentation should be carried out at the national level with a number of states participating which could lead to MUTCD approval.

EVALUATION OF ICE ALERT®

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1.0 BACKGROUND

One of the goals of road and highway agencies has been to reliably warn motorist of hazardous conditions, particularly the presence of ice on the roadway. The assumption is that, if motorists are aware of roadway conditions, they will respond with caution.

Oregon started experimenting with ice detection systems in 1980 with the installation of Road Weather Information Systems (RWIS) on the Freemont Bridge in Portland, and at Quartz Creek Bridge on US 26 in the Coast Range. Subsequently, RWIS have been installed in the Bend area on US 97, and on the I-205 Glenn Jackson Bridge over the Columbia River in Portland. Depending on the site, these systems employ temperature sensors embedded in the pavement along with, precipitation, air temperature, dew point, wind speed and direction, and frost warning devices. These systems typically cost $50,000 to $80,000.

The manufacturers do not claim 100% accuracy and because the state and the manufacturers are both concerned about liability they do not recommend that the devices be used to warn drivers directly. Instead, these systems are generally used to notify highway maintenance personnel of weather conditions at the site. This information may be used to plan and execute ice or snow removal. Sometimes maintenance personnel use them as a basis to activate ice warning signs.

In Finland, variable message signs are used to advise motorists of both air and pavement temperatures provided by RWIS. This approach leaves the decision making to the individual driver.

Passive temperature sensitive devices using liquid crystal technology to change the color have been evaluated in the past with little success. One problem with these devices is that the color filter process used to change the color leaves the device with low reflectivity.

2.0 THE DEVICE

In the late 1980's, Oregon State Highway Division, now Oregon Department of Transportation (ODOT), was approached about a device called Ice Alert®. The device was described as a way to alert drivers to the possible presence of ice on the road. Because claims that this device would result in increased safety for motorists were based on anecdotal evidence and subjective opinion rather than objective data, ODOT management requested an evaluation of Ice Alert®.

The device had been evaluated by a number of states, including Arizona, California and Washington. None of these states, to our knowledge, has adopted the device as a standard. The primary reasons cited by Washington were erratic performance and liability issues. (See Appendix F)

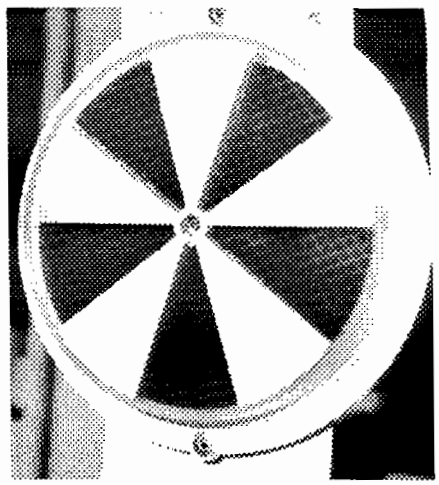


Figure 2.1 - Ice Alert® Device

2.1 DESCRIPTION

The Ice Alert® is a 127 mm (5") diameter round reflective device. A temperature-driven spring rotates a colored reflective disk behind a mask in response to changes in air temperature. When air temperature is above freezing, a white reflective sheeting is exposed. (This is the closed position.) When air temperature is below freezing, a blue reflective sheeting is exposed. (This is the opened position.) Note that Ice Alert® does not indicate pavement temperature which can vary as much as 6°F from the air temperature.

The device is intended to be mounted on delineator posts in lieu of conventional reflectors. However, while replacing a traffic control device, Ice Alert® is not covered in the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD and the Oregon supplements to the MUTCD, are the legal standard for traffic control devices in Oregon. Also, the blue color has no standard meaning or designation when used for a traffic control device.

3.0 THE STUDY

3.1 STUDY HISTORY

In the winter of 1990-91, an extensive study of the device was planned. The study was to begin in the spring of 1991.

3.2 OBJECTIVES

3.2.1 Hypothesis:

The hypothesis being tested is: **"If motorists are aware of roadway conditions, they will respond with reduced speed and increased caution."**

3.2.2 Feasibility

Evaluate the feasibility of widespread use of Ice Alert®.

3.2.3 Implementation

Provide recommendations to ODOT management about the use of this device.

3.3 SITE SELECTION CRITERIA

Testing sites selected for the winter of 1991-92 (Figure 3.1) met the following criteria:

- Be in a rural, or semi-rural area away from roadside lighting sources that may interfere with the device's reflectivity and effectiveness.
- Have a history of ice-related traffic problems.
- Be in an area subject to regular freeze/thaw cycles, or in an area where ice may be present when most other areas are clear.

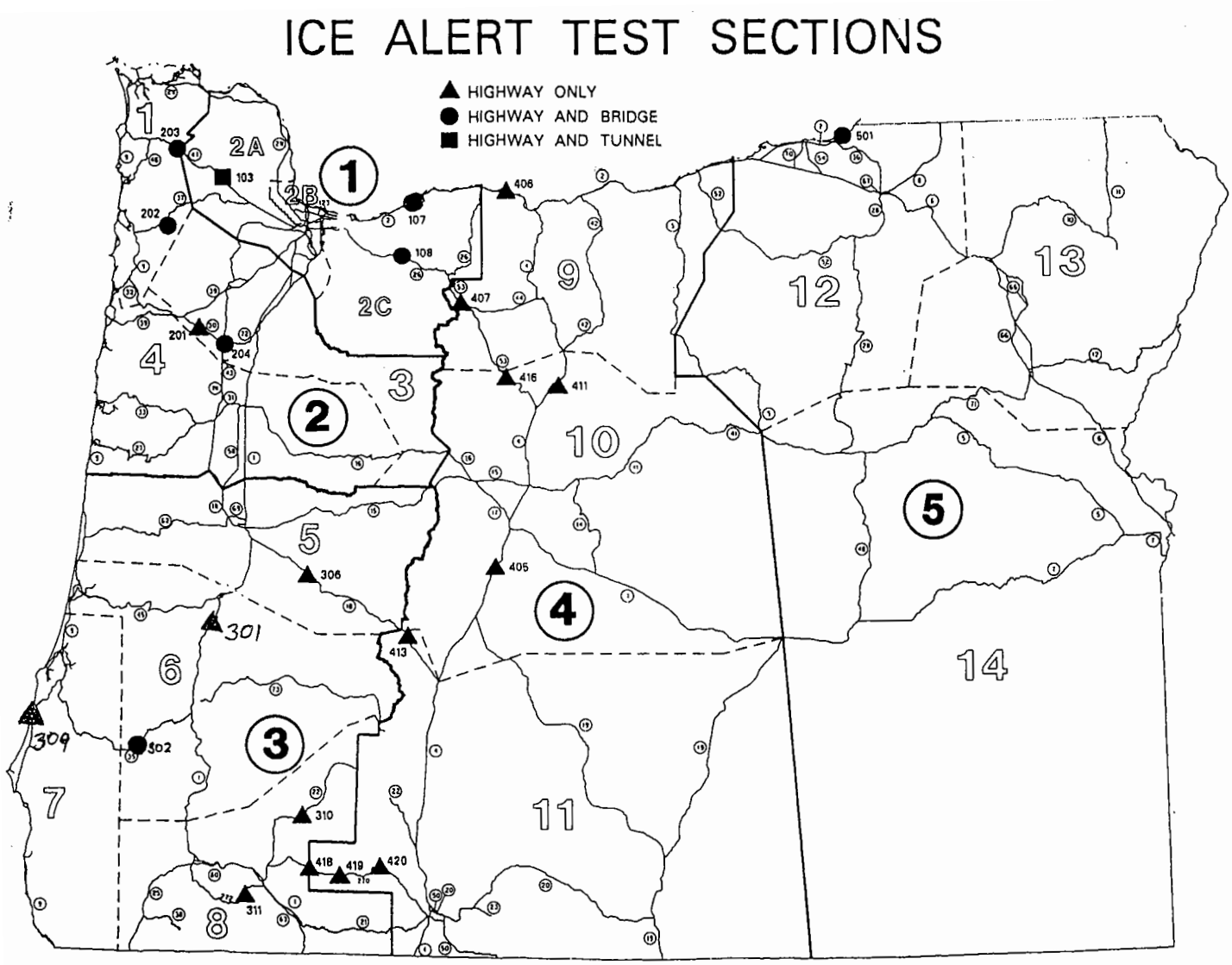


Figure 3.1 - Winter 1991-1992 Evaluation Sites

3.4 EVALUATION ELEMENTS

3.4.1 Laboratory Testing

Test the basic characteristics of the device in the laboratory.

3.4.2 Operational Issues

Evaluate the operational aspects of the device including durability.

3.4.3 Motorist Reaction

Determine the reaction of the motoring public to the presence of the devices.

3.4.4 Speed Reduction

Determine if drivers actually reduce their speed in response to a "below freezing" (blue) indication on the Temperature Sensitive Roadside Reflectors (TSRR's).

4.0 LABORATORY TESTING

In the winter of 1989-90, a previous design of the device was tried in Oregon in limited locations without a clear plan of study. This 76 mm (3" diameter) device was not as reliable or as reflective as the current 127 mm (5" diameter) device. In 1991, the present device was lab tested for reflectivity and temperature sensitivity.

4.1 REFLECTIVITY

In February of 1991, the present 127 mm (5") devices were tested for reflectivity and met the current ODOT standards for minimum specific intensity. Pieces of 76 mm (3") by 102 mm (4") high-intensity tape were used as references. The results are shown in Table 1.

There are no ODOT specifications for total reflected light for a delineator reflector. However, there are standards for the minimum specific intensity for reflective sheeting on delineators. For the purpose of the test, the reflectivity of the devices were compared with a 0.833 square foot piece of high-intensity reflective tape.

Table 1.1 - Ice Alert® Reflectance Testing

Color	Entrance Angle	Observation Angle	Minimum Reflected Light Required[1]	Reflected Light	
				Tape	Ice Alert®
White	- 4°	0.2°	20.8	28.0	53.8
White	+30°	0.2°	12.5	26.7	24.7
White	+60°	0.2°	10.0	18.6	14.8
Yellow	- 4°	0.2°	14.2	18.8	36.0
Yellow	+30°	0.2°	8.3	17.2	17.3
Yellow	+60°	0.2°	6.7	13.7	11.3
Blue	- 4°	0.2°	1.7	2.9	12.9
Blue	+30°	0.2°	0.9	2.5	8.1
Blue	+60°	0.2°	-	1.7	4.6

[1] Candelas per foot/candle

4.2 TEMPERATURE SENSITIVITY

In February of 1991, and again in July of 1991 the devices were tested in the environmental chamber of the Traffic Signal Services Unit (TSSU). The objective was to look at the devices overall temperature sensitivity as well as determine some measure of performance.

The Ice Alert® devices tested in February of 1991 opened satisfactorily but did not close on increasing temperature as expected. The manufacturer recalled the devices and made modifications. These new devices were tested July, 1991.

Thirty-four Ice Alert® devices were tested under extreme conditions. Two testing cycles -- one of decreasing temperature and one of increasing temperature--were completed over 48-hour interval. During this test, the device was exposed to a high of 66°C (150°F) and a low of -37°C (-35°F). One device failed to close on the increasing temperature cycle.

Additional tests were made to determine the performance of these devices under normal winter conditions during which "black ice" might form. (See Appendix A) These tests consisted of a slow freeze and a slow thaw cycle in which temperatures ranges from -2°C (28°F) to a constant temperature of 3°C (37.5°F). On the slow freeze cycle, after 1 hour and 49 minutes above freezing, 97.1% of the devices had closed (white position). After 37 minutes below freezing, all of the devices were 100% opened (blue position).

It should be noted that some of the devices closed (white position) before the rising temperature was above freezing. The manufacturer says that this can be remedied by better calibration.

The remainder of the shipment was tested July 30, 1991 for operation at 10°C (50°F) to -10 °C (14°F). Of the 131 tested, 3 failed to operate satisfactorily for an overall failure rate of 2.4%.

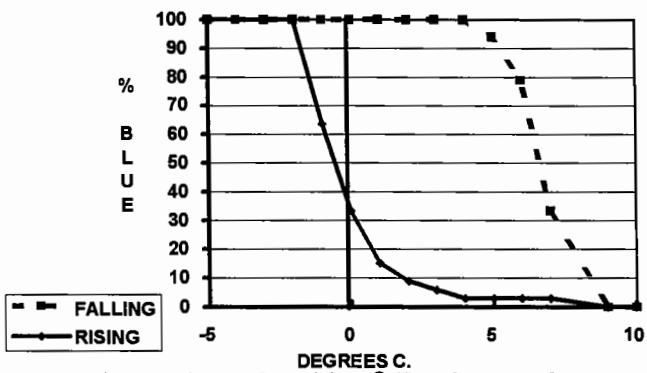


Figure 4.1 - Ice Alert© Device Performance

5.0 OPERATIONAL EVALUATION-WINTER 1991-1992

The winter of 1991-1992 was relatively mild. While limiting the number of days of freezing weather for testing purposes, the erratic nature of the weather gave the device a realistic test in that it is designed for areas where frosty conditions are neither predictable nor continuous.

5.1 INSTALLATION

The devices were installed at 20 (Figure 3.1) sites using the manufacturers recommendations (Appendix B). Costs for the installations, including paddles and steel posts, averaged $70.70 per installed reflector plus an additional $450 for the necessary signing. Total cost was about $55,000.

To meet liability concerns, a sign (Figure 5.1) was designed to accompany the installations.

Figure 5.1 - Site Advisory Sign

5.2 OPERATIONAL EVALUATION

Reports indicated that the public, for the most part, responded well to the presence of the Ice Alerts®. However, a number of observers reported inconsistency in performance, probably due to variations in cloud cover, shading, and sun angle. One report noted that the devices turned white as soon as the sun struck them. Some observers had difficulty identifying the color of the device at dawn and dusk; others had no trouble with visibility.

One thing that affected visibility was dirt. It was a practical problem to keep the reflectors clean in high traffic and heavy snow areas. Significant maintenance was needed to keep the devices in working condition.

The greatest problem was with vandalism and theft. Maintenance crews replaced 313 reflectors out of the 652 originally installed. The cost for replacement was about $11,000 or an average of $17.03 per unit. (See Appendix D for maintenance personnel comments.)

6.0 MOTORIST REACTION

The evaluation of the Ice Alert® included testing the hypothesis that motorists, if made aware of potentially dangerous road conditions, would reduce their speed and increase caution. This hypothesis was tested by an independent survey of drivers in the test site area and by actual speed measurements.

6.1 MOTORIST SURVEY

In February 1992, a consultant survey was made of 340 drivers in the Ice Alert® test site areas. Of those drivers contacted by phone, 59% (200) were aware of the devices and had driven the test section within the previous two months. These respondents were selected to complete the entire survey.

When asked about the appearance and function of the devices, 86% (172) of those interviewed knew that blue indicated freezing temperatures. It is important to note, however, that many motorists also connected the blue color with icy conditions. Of those interviewed, 79% (158) said the device turns blue if the temperature is freezing or icy; 26% (52) said it stays silver or white if it is not freezing or icy.

Of those interviewed, 74% (148) believed Ice Alert® would be an effective way to warn drivers of potentially dangerous driving conditions. However, it was noted by some maintenance crews that out-of-state drivers did not understand the message.

Most respondents, 90% (179) said they would alter their driving behavior if the Ice Alerts® showed blue, indicating freezing temperatures. Of those, 82% (145) said they would reduce their speed.

Of the survey respondents, 53% (106) had driven the road when temperatures were below freezing; of those, 57% (60) said that they had altered their driving behavior, 87% by reducing speed.

6.2 SPEED REDUCTION

Speed data was gathered along with temperature measurements at three sites. Speed was measured in advance of and at the end of the test section to determine the effect of the devices. Figure 6.1 shows the difference in mean vehicle speed before the test site and at the end of the test section. While slower overall speeds were detected during periods of frost, no significant reduction in speeds was recorded at the test sites. Indicating that there was a general trend among motorists to slow down during times of freezing temperatures and that slower speeds were not an effect of the Ice Alert®.

It should be noted that, while the motorists said they would reduce speed when they encountered the devices showing blue, the 2 mph reduction shown in Figure 6.1 was not significant given that the accuracy of the measuring device was ± 1 mph.

It can be concluded that the devices did not cause a general slowing of traffic and, by implication did not reduce the potential for ice-related accidents.

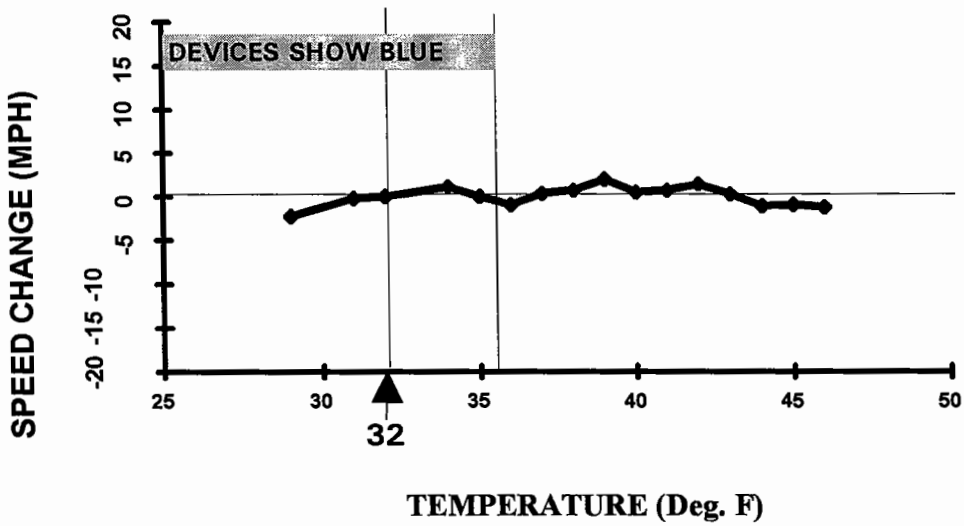


Figure 6.1 - Speed Reduction

7.0 WINTER 1992-93

For the winter of 1992-1993, the advisory committee suggested a change in the deployment of the devices to address the problems with theft, vandalism, and cleaning. This change involved designing a sign, as shown Figure 7.1, with three of the devices attached. This sign would be installed using ODOT standards for height and distance from traveled way.

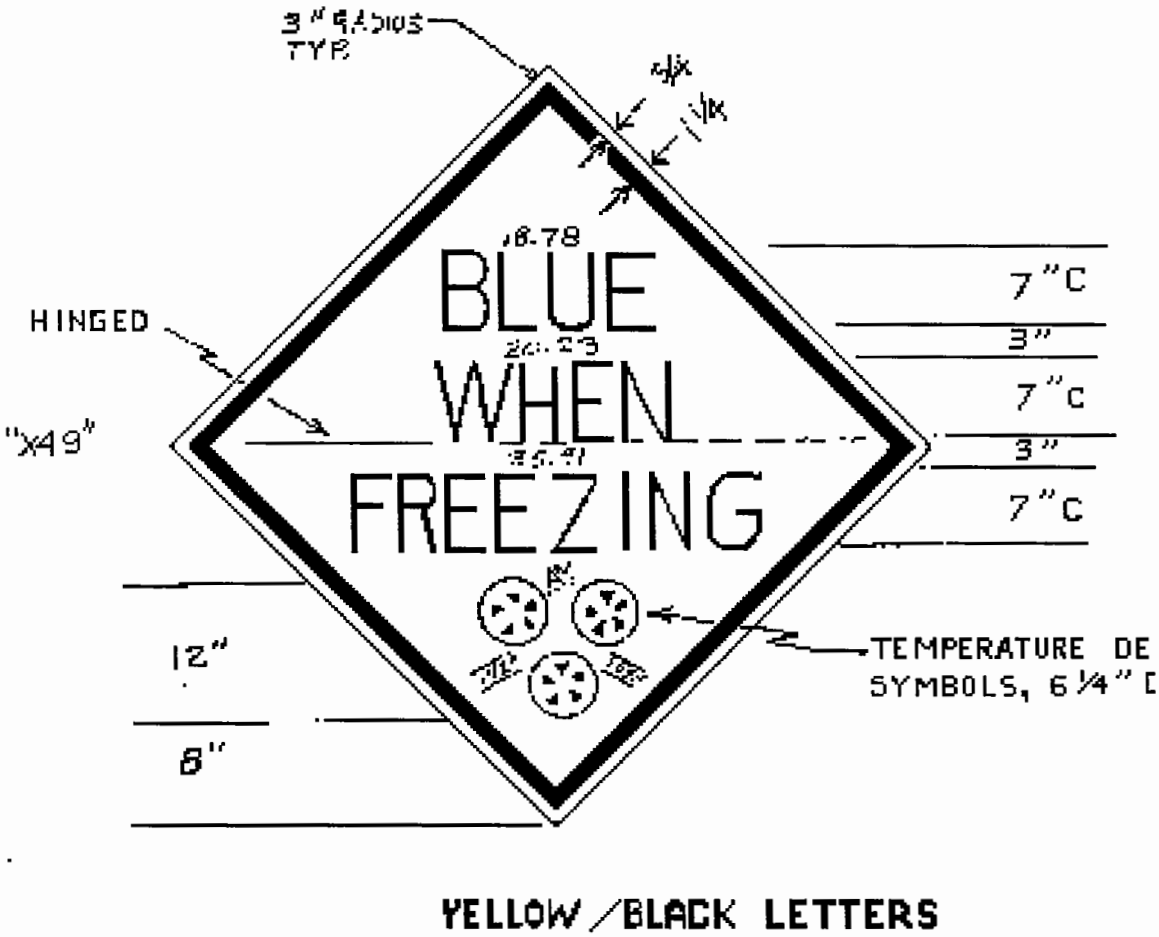


Figure 7.1 - Ice Alert Sign 1992 - 93

7.1 SITE CRITERIA

- Be in a rural, or semi-rural area away from roadside lighting sources that may interfere with the device's reflectivity and effectiveness.
- Have a history of ice-related traffic problems.
- Be in an area subject to regular freeze/thaw cycles, or in an area where ice may be present when most other areas are clear.
- Be west of the Cascade summit (NEW CRITERIA).
- Be located on a non-freeway, primary, or secondary highway (NEW CRITERIA).

7.2 INSTALLATION

Twenty sets of modified signs were installed in western Oregon during the fall of 1992.

7.3 PERFORMANCE

Districts reported that the general performance of the sign-mounted devices was poor. Most were taken down because the indications were extremely erratic. Visibility was also a problem in that the devices were mounted above the normal plane of headlights.

7.4 DISCUSSION

Overall, the sign concept did not achieve the objective of warning the motorist, due to poor visibility and erratic device performance.

8.0 RISK MANAGEMENT

The Risk Management Unit of the Department of Administrative Services (DAS) voiced liability concerns over the inconsistent performance of the devices and the problem of no generally accepted standard for use. (See Appendix E)

8.1 AIR AND PAVEMENT TEMPERATURES RELATIONSHIP TO ICE FORMATION

In Oregon, and most places, there are significant differences in air and pavement temperatures, particularly on bridge decks. The reason is that air and pavement have different heat transfer characteristics. Air gains, or loses, heat easily while pavement gains or loses heat much more slowly. For these reasons, the pavement may be significantly (1° - 6° F) warmer or cooler than the air at any time. The actual difference is highly dependent on soil temperature, humidity, presence of water, cloud cover, sunlight, and, to an extent, traffic.

Scenario 1 - Falling Temperature, Warm (> 35° F) Pavement

The pavement temperature will be warmer (1° - 6° F) than the air until the air temperature reaches freezing and the pavement loses sufficient heat to allow freezing. The actual difference will depend on humidity, cloud cover, sunlight, and the presence of water.

Scenario 2 - Falling Temperature, Cool (33° - 35° F) Pavement

The pavement temperature will be warmer (1° - 3° F) than the air until sufficient heat is lost to allow freezing. Once again, the difference will depend on humidity, cloud cover, sunlight and presence of water.

Scenario 3 - Rising Temperature, Cold (28° - 32° F) Pavement

The pavement will remain colder (1° - 4° F) than the air until sufficient heat is gained to raise the pavement temperature above freezing. This process is highly dependent on the amount of cloud cover, sunlight, and, to a lesser extent, humidity.

Scenario 4 - Rising Temperature, Frozen (< 28° F) Pavement

The pavement will remain colder (1° - 6° F) than the air until sufficient heat is gained to raise the temperature above freezing. This process is highly dependent on the amount of cloud cover and, less so, on humidity. It is possible, on days with heavy cloud cover and high humidity, that ice will form on the pavement when air temperatures are as high as 36°F.

Implications:

Because ice may remain on the road after air temperatures are above freezing, any device that depends on the measurement of air temperature alone will not reliably warn of the presence of ice or the extent of the icing condition.

9.0 CONCLUSIONS

In evaluating the Ice Alert® devices, the hypothesis was tested that, if motorists were made aware of road conditions--particularly the potential for ice on the road--they would respond with reduced speeds and increased caution. To test the hypothesis a telephone survey of three-hundred-forty motorists from the test site areas-was performed. Two hundred of the respondents said they were aware of the devices- and indicated that drivers might indeed react to the devices with reduced speeds and increased caution.

The fifty-nine percent of the survey respondents who had seen the device indicating the potential for ice said that they reduced speed. Ninety percent of the drivers in the survey said they would change their driving behavior if the device indicated the potential for ice. Most said they would reduce speed.

Speed measurements made in three Ice Alert® test areas showed no significant reduction in speed by motorists when the devices indicated the potential for ice. Even though the majority of the respondents indicated they would reduce speed when the Ice Alert® indicated the potential for ice, this study showed that the potential for ice-related accidents was not reduced by slowing of the traffic.

Also, Ice Alert® measures air temperature, not pavement temperature. Due to the difference that can exist between air and pavement temperature, the device can (indicate above freezing temperatures) when there is, in fact, still ice on the road. This presents a significant potential for tort claims because the public perceives the devices as ice warnings, and not merely temperature indicators. One district report specifically mentioned that truck drivers use the devices to locate ice on the road.

Use of the devices may also pose significant liability problems. Ice Alert® devices are not covered by the manual on Uniform Traffic Control Devices (MUTCD) or the Oregon supplements to the MUTCD. The MUTCD and the Oregon supplements to the MUTCD are the legal standards for traffic control devices in Oregon. Legal counsel has advised that by installing the devices, the State warrants their accuracy, despite the fact that the manufacturer provides no warranty for performance or accuracy.

10.0 RECOMMENDATIONS

1. Discontinue general experimentation with the devices until the manufacturer can show improved accuracy.

2. Any further experimentation should be carried out at the national level with a number of states participating which could lead to MUTCD approval.

The Committee on Traffic Control Devices, consisting of representatives from cities, counties, Oregon State Police, and ODOT, as well as, private consultants, also concurs in these recommendations.

Appendix A

TEMPERATURE TEST RESULTS

TIME	TEMP °C	OPEN	CLOSED	TRANSIT	COMMENTS
7-25-91					
9:37 am	-9	34			
11:27 am	+14	1	33		1 did not close
11:40 am	+6	1	33		
1:00 pm	-6	34			
1:20 pm	-6	34			
2:40 pm	+6	1			
3:10 pm	+6	1			
4:00 pm	-1	21			
4:10 pm	-3	34			
7-26-91					
9:15 am	-6	34			
10:50 am	+4	1	33		
11:00 am	+7	1	33		
11:20 am	-1	3	6	25	
11:40 am	-1	30		4	
11:47 am	-2	34			Ice formed on A.C.
12:20 pm	-4	34			
12:40 pm	+2	34			
12:55 pm	+3	10		24	
1:30 pm	+3	1	25	8	4 yellows at ¼ open
1:55 pm	+5	1	33		
2:00 pm	-5	1	33		
2:20 pm	-5	34			
2:35 pm	+6	26	2	6	
3:02 pm	-5	34			
3:20 pm	-5	34			
3:30 pm	+7	34			
3:50 pm	+6	1	32	1	1 yellow at ¼
4:00 pm	0	1	32	1	
4:20 pm	0	1	10	23	

TIME	TEMP °C	OPEN	CLOSED	TRANSIT	COMMENTS
7-29-91					
10:20 am	-16	34			
10:40 am	+1	34			
10:50 am	+2	34			
10:56 am	+3	34			
11:55 am	+3	1	32	1	1 yellow at ¼
12:15 pm	+3	1	33		all whites closed at 11:45
12:20 pm	0	1	33		
1:25 pm	0	18		16	
1:31 pm	-2	32	1	1	

SLOW FREEZE/THAW

7-26-91 -- SLOW FREEZE

TIME	TEMP °C	Δt °C	Δt MIN	% OPEN	% CLOSED	% TRANSIT
11:00 am	+7					
11:10 am	0	+7	10	0	100	
11:20 am	-1	-1	1-	6.1	18.2	75.7
11:30 am	-1	0	1-	63.6		
11:40 am	-1	0	10	87.8		
11:47 am	-2	-1	7	100[1]		

7-29-91 -- SLOW THAW

TIME	TEMP °C	Δt °C	Δt MIN	% OPEN	% CLOSED	% TRANSIT
10:20 am	-16			100		
10:40 am	+1	+17	20	100		
10:50 am	+2	+1	10	100		
10:56 am	+3	+1	6	100	0	
11:05 am	+3	0	11	58	0	42.0
11:10 am	+3	0	5	11.8	8.8	79.4
11:15 am	+3	0	5	2.9	17.6	79.5
11:20 am	+3	0	5	2.9	50.0	47.1
11:25 am	+3	0	5	2.9	67.6	29.5
11:30 am	+3	0	5	2.9	73.5	23.6
11:35 am	+3	0	5	2.9	85.3	11.8
11:40 am	+3	0	5	2.9	88.2	8.9
11:45 am	+3	0	5	2.9	91.1	
11:50 am	+3	0	5	2.9	94.1	
11:55 am	+3	0	5	2.9	94.1	
12:15 pm	+3	0	5	2.9	97.1	

[1] Ice formed on A.C. core samples placed in 5-gallon bucket, which was filled with dirt and rock and placed near ice alerts in chamber.

ICE ALERT® TEMPERATURE SENSITIVITY TESTING

TIME 7-29-91	TEMP °C	FULLY OPEN	TRANSITION	CLOSED
10:20 a.m.	-15	33 0	0	
10:40 a.m.	0	33 0	0	
10:50 a.m.	+2	33 0	0	
10:56 a.m.	+3	33 0	0	
11:05 a.m.	+3	19	14 0[2]	
11:10 a.m.	+3	3	27 3[3]	
11:15 a.m.	+3	0	27 6	
11:20 a.m.	+3	0	16 17	
11:25 a.m.	+3	0	10 23	
11:30 a.m.	+3	0	8	25
11:35 a.m.	+3	0	4	29
11:40 a.m.	+3	0	3	30
11:45 a.m.	+3	0	2	31[4]
11:50 a.m.	+3	0	1	32[5]
11:55 a.m.	+3	0	1	32[6]
12:15 p.m.	+3	0	0	33
12:20 p.m.	0	0	0	33
12:25 p.m.	0	0	0	33
12:30 p.m.	0	0	0	33
12:35 p.m.	0	0	9	24
12:40 p.m.	0	1	15 17	
12:45 p.m.	0	1	23 9	
12:50 p.m.	0	3	26 4	
12:55 p.m.	-1	4	28 1	

ICE ALERT® TEMPERATURE SENSITIVITY TESTING

TIME 7-29-91	TEMP °C	FULLY OPEN	TRANSITION		CLOSED
1:00 p.m.	0	7	25	1	
1:05 p.m.	-1	11	22	0	
1:10 p.m.	-1	12	21	0	
1:15 p.m.	-1	16	17	0	
1:20 p.m.	0	16	17	0	
1:25 p.m.	0	17	16	0[7]	

[2] Yellow all at 100%
[3] Yellow all at 75%
[4] All white closed
[5] One yellow at 1/4
[6] One yellow at 1/4
[7] Yellow all at 25%

Appendix B

INSTALLATION GUIDELINES

Ice Alert® Installation Instructions

1. It is most important that Ice Alert® not be interspaced or mixed in any way with other reflectors. To be effective, Ice Alert® must be used in a series exclusive of other reflective devices.

2. HEIGHT: Ice Alert® should be mounted approximately four (4) feet above the near roadway edge on standard guideposts - steel or plastic.

3 BRIDGES: Distances from bridge entrance:

SPEED	1 st	2nd	3rd	4th	5th	6th	7th	8th
20	at bridge	10'	21'	44'	87'	175'	240'	240'
25	"	15'	31 '	62'	125'	240'	240'	240'
30	"	20'	40'	81 '	162'	240'	240'	240'
35	"	25'	50'	100'	200'	240'	240'	240'
40	"	30'	60'	118'	237'	240'	240'	240'
45	"	34'	68'	137'	240'	240'	240'	240'
50	"	39'	78'	156'	240'	240'	240'	240'
55	"	43'	87'	175'	240'	240'	240'	240'
60	"	48'	97'	193'	240'	240'	240'	240'
65	"	53'	106'	212'	240'	240'	240'	240'

On bridges of 100' or longer length, Ice Alert® should be placed every 50' on the railing.

4 CURVES: Spacing should be adjusted on approaches and throughout horizontal curves so that several Ice Alerts® are always visible to the driver.

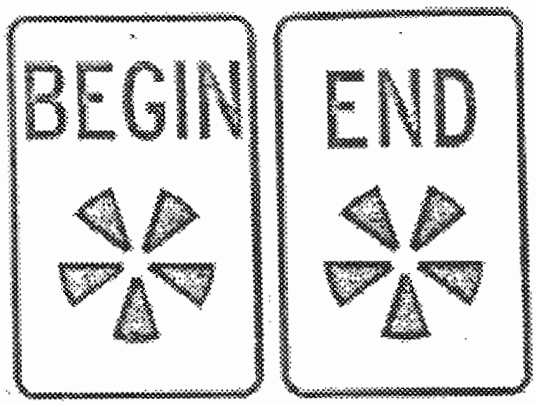
Table of Suggested Spacing on Horizontal Curves

Radius of curve in Feet	Spacing in Feet
50	20
150	30
200	35
250	40
300	50
400	55
500	65
600	70
700	75
800	80
900	85
1000	90

Spacing for specific radii not shown may be interpolated from the table. The minimum spacing should be 20', the maximum should not exceed 240'.

5. ROADWAYS: Ice Alert® should be placed as recommended for standard delineators in the Delineation Section of the MUTCD keeping in mind that they work in a series and must not be mingled with other types of markers.

6. INTERMITTENT USE: When conditions dictate that Ice Alert® be used intermittently, an international symbol has been designed to advise the motorist where the Ice Alert® system begins and ends.



7. SIGNING: Explanatory signs are not recommended The best way to introduce Ice Alert® to the public is through the news media (i.e., newspapers and local television stations) and exposure through use. If signing must be used, a simple "Blue markers indicate freezing temperatures," on a rectangular sign with the suggested ice warning symbol in blue.

8. MOUNTING: The device has top and bottom holes on 1" spacing for post mounting. The words "Ice Alert®" will appear for "right side up".
Ice Alert® MUST NOT be mounted over or near other reflective surfaces.

Appendix C

INTERCEPT RESEARCH CORPORATIONS HIGHWAY ICE ALERT® DRIVER ASSESSMENT SURVEY RESEARCH METHODOLOGY AND EXECUTIVE SUMMARY

OREGON DEPARTMENT OF TRANSPORTATION

Highway Ice Alert
Driver Assessment Survey

Executive Summary and
Data Cross-Tabulations

February, 1992

Intercept Research Corporation

TABLE OF CONTENTS

RESEARCH METHODOLOGY

Intercept Research Corporation

METHOD

Telephone interviewing was the survey method used.

EXTRACTION

A computer assisted, random-digit dialing technique was employed to supply telephone numbers in areas where ice alert devices are being tested by the Oregon Department of Transportation. The following test sites were targeted for the survey:

- Coastal Segment: Route 26 between Manning and Elsie (Site numbers 103 and 203)
- Mt. Hood Segment: Route 26 between Sandy and Madras (Site numbers 108, 407 and 416)
- Southern Segment: Route 140 between Medford and Klamath Falls (Site numbers 418, 419 and 420)

SAMPLE

The sample consists of 200 completed interviews. All participants in the survey were screened to meet the following qualifications:

- Licensed driver
- Having driven on designated roadway during the past two month period
- Aware of ice alert devices

INTERVIEWING

All data collection was conducted from Intercept Research's telephone interviewing facilities from February 4 through 6, 1992 from 5:00 to 9:00 p.m.

PROCESSING

All functions related to the processing of the survey data were completed in-house by Intercept Research Corporation's data processing department.

RELIABILITY

The table below illustrates the (plus or minus) range of variability at different percentages of response computed at the 95% confidence level:

RESPONSE PERCENTAGE	100 SEGMENT	200 SEGMENT
10% or 90%	5.9%	4.3%
20% or 80%	7.8%	5.7%
30% or 70%	9.0%	6.5%
40% or 60%	9.6%	7.0%
50%	9.8%	7.1%

EXECUTIVE SUMMARY

Intercept Research Corporation

Almost six in ten (59%) of those contacted were aware of the highway ice alert devices being tested along sections of roadway in their area.

Question: *Did you notice the highway ice alert devices which are being tested along this section of roadway?*

	(N = 340)
Yes	59%
No	41%

A significant number (79%) of those surveyed describe the ice alert as a device which turns blue in freezing or icy conditions.

Question: *Please describe what the the ice alert device looks like and how it works.*

Multiple Response

	(N = 200)
Turns blue if temperature freezing/icy	79%
Round sign/small circle/three to four-inch disk	47%
Reflector device	32%
Triangular reflectors	32%
Stays white/silver/gray if not freezing/icy	26%
Mounted on post/looks like milepost marker	15%
Located on side of road	7%
Sign was rectangular/square	7%
Changes color when temperature freezing	6%
Sign that explains the ice alerts' purpose/how they work	5%
They are placed in appropriate places/test areas	3%
A light comes on/changes color if freezing	3%
Other	5%
Don't know	3%

Residents of the Coastal segment, respondents 35 years of age and younger, those with some college experience or less, and individuals who last drove the test section in January or February are more likely than the sample as a whole to describe the ice alert as a device which turns blue when temperatures are freezing or icy.

Residents of the Coastal segment, respondents over 55 years of age and college graduates, motorists who last drove the test section in January are more likely than the sample as a whole to describe the ice alert as a small disk or round sign.

Residents of the Mt. Hood segment, male respondents and individuals 26 to 35 years of age and motorists who last drove the test section in December are more likely than the sample as a whole to mention that the ice alert is a reflector.

Residents of the Southern segment and respondents 36 to 45 years of age are more likely than the sample as a whole to describe the ice alert as a triangular reflector.

Survey respondents overwhelmingly recognize the function or purpose of the highway ice alert devices.

Question: *What do you believe is the function or purpose of these highway ice alert devices?*

Multiple Response	*(N = 200)*
To warn motorists of icy conditions/black ice	79%
Cautions motorists to slow down	38%
Cautions motorists to drive more carefully/alertly	28%
To alert motorists of freezing conditions	19%
To warn motorist of road conditions/icy spots before they get there	7%
To promote safety/save lives/prevent accidents	6%
To warn motorists about ice that they can't see	4%
Cautions motorists to drive defensively/watch out for other drivers	3%
Other	4%
Don't know	3%

Residents of the Mt. Hood segment, female respondents, individuals 45 years of age or younger, those with a high school education or less and respondents earning less than $30,000 per year are more likely than the sample as a whole to believe the function of the ice alert device is to warn motorists of icy roadway conditions.

Respondents over 45 years of age and those earning less than $35,000 per year are more likely than the sample as a whole to believe the primary function of the ice alert device is to caution motorists to reduce their speed.

Residents of the Southern segment, female respondents, those 46 to 55 years of age, high school graduates or college graduates and individuals earning $30,000 or more per year are more likely than the sample as a whole to believe the primary function of the ice alert device is to caution motorists to drive more carefully or alertly.

Male respondents, those 45 years of age or younger, college graduates and individuals earning $30,000 or more per year are more likely than the sample as a whole to believe the primary function of the ice alert device is to warn motorists of freezing temperatures.

A majority (86%) of the survey sample correctly specify "blue" as the color signifying freezing temperatures.

Question: *The ice alert devices being tested turn a specific color when temperatures drop to freezing levels - do you recall what color that is?*

	(N = 200)
Blue	86%
Other color	3%
Don't know	11%

Respondents 26 to 35 years of age and individuals earning $30,000 or more per year are more likely to specify "blue."

Approximately one-half (53%) of those surveyed have driven the test section when cold temperatures activated the ice alerts.

Question: *Have you driven this section of highway when the temperature was cold enough to cause the devices to turn blue?*

	(N = 200)
Yes	53%
No	47%

Male respondents, individuals between the ages of 26 and 45 and non-college graduates are more likely than the sample as a whole to have observed an ice alert during periods cold enough to turn the device blue.

Almost six in ten (57%) of the survey participants who observed an activated ice alert altered their driving behavior.

Question: *When you noticed the ice alert devices were blue, did you change your driving behavior?*

	(N = 106)
Yes	57%
No	42%

Residents of the Coastal segment, respondents under 26 and those between the ages of 46 and 55 and college graduates are more likely than the sample as a whole to indicate their driving behavior changed after noticing the activated ice alert devices.

Question: *How did you change your driving behavior?*

Multiple Response

	(N = 60)
Reduced speed	87%
Drove more cautiously	27%
Looked for ice/wet spots	13%
Became more alert	12%
Became more careful/slower on curves	12%
Avoided sudden stops/hard braking/quick moves	10%
Drove defensively/watched other drivers more	8%
Engaged four-wheel drive/chained up	3%

A majority (90%) of survey participants indicate their driving behavior would be affected if they observed activated ice alerts in the future.

Question: *If you were to drive this section of highway in the future, do you think your driving behavior would be affected if you noticed the highway ice alert devices had turned blue?*

	(N = 200)
Yes	90%
No	8%
Don't know	3%

Male respondents and individuals between that ages of 36 and 45 are less likely than the sample as a whole to indicate their driving behavior would be affected if they observed activated highway ice alert devices.

Question: *How would your driving behavior change?*

Multiple Response

	(N = 179)
Reduce speed	82%
Drive more cautiously	36%
Be more alert	18%
Drive more defensively/watch for other drivers	15%
Look for ice/wet spots	13%
Avoid sudden stops/hard braking/quick turns	9%
Be more cautious/slower on curves	6%
Maintain a safe distance between vehicles	3%
Engage four-wheel drive/chain up	3%
Look for/pay attention to shaded areas	2%

Approximately three-quarters (74%) of those responding believe the highway ice alert devices are an effective means of warning drivers of potentially dangerous driving conditions (combined "4" and "5" ratings).

Question: *On a scale of one to five, how effective do you believe these highway ice alert devices are in warning drivers of potentially dangerous driving conditions?*

	(N = 200)
1.00 = Not effective at all	4%
2.00	3%
3.00	14%
4.00	30%
5.00 = Very effective	44%
Don't know	8%
Mean Rating	*4.16*

Female respondents and individuals over 45 years of age are more likely than the sample as a whole to believe the highway ice alert devices are an effective warning.

Of the four evaluative criteria tested, respondents rate the ice alert signs highest for being easy to understand (4.13) and lowest for attracting the attention of drivers (3.29).

Question: *Now I'd like you to evaluate the signs which are posted to notify drivers of the ice alert devices. On a scale of one to five, how would you evaluate these signs on the following:*

Mean Rating *Scale: 5.00 = Excellent, 1.00 = Poor*	*(N = 200)*
Being easy to understand	4.13
Providing drivers with enough information	3.92
Being easy to read	3.81
Attracting the attention of drivers	3.29

Residents of the Mt. Hood segment tend to rate the ice alert signs higher than the sample as a whole for being easy to read as do drivers who have not observed the ice alerts when activated (blue).

Respondents 35 years of age and younger and drivers who have not observed the ice alerts when activated (blue) tend to rate the ice alert signs higher than the sample as a whole for being easy to understand.

Respondents 26 to 35 years of age tend to rate the ice alert signs higher than the sample as a whole for providing drivers with enough information.

Respondents 46 to 55 years of age tend to rate the ice alert signs higher than the sample as a whole for attracting the attention of drivers.

Nine out of ten survey respondents (92%) have encountered icy conditions while driving on the test section of roadway where the ice alerts are located.

Question: *In your experience, have you ever encountered icy conditions while driving on this particular section of highway?*

	(N = 200)
Yes	92%
No	9%

Question: *Do you recall on what day you last drove this section of highway?*

	(N = 200)
December	15%
January	49%
February	34%
Don't know	2%

Question: *And what time of day did you last drive this section of highway?*

	(N = 200)
Noon or before	45%
After noon	53%
Don't know	2%

Question: *Gender:*

	(N = 200)
Male	53%
Female	48%

Appendix D

MAINTENANCE COMMENTS 1991-1992

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 1 DISTRICT 2A MANNING SECTION

USAGE	They seem to function reasonably well Feedback from local residents thought they were helpful
VISIBILITY	Visibility seems reasonably good
MAINTENANCE	Some were located inside tunnel, needed occasional washing
INSTALLATION	No problems
OTHER	Need improved mounting brackets for buttons. 35 ice alerts stolen They are expensive to maintain

REGION 1 DISTRICT 2C CASCADE LOCKS SECTION

USAGE	Turned at different times 34 - 30 degrees Problems with dirt - washing needed
VISIBILITY	Can't see them at all, covered with grime we don't pay attention to them
MAINTENANCE	Accumulate dirt & grime
INSTALLATION	
OTHER	Cost too much, our budget can not stand the cost

REGION 1 DISTRICT 2C SANDY SECTION

USAGE	Highly visible when temp below freezing Truck drivers using them to detect ice (from CB radio)
VISIBILITY	No problems
MAINTENANCE	Vandalism & theft. Suggest removal during good weather
INSTALLATION	
OTHER	Yellow device turns about 2 degrees ahead of white Sign device would turn white as soon as sun hits sign. Recommend other areas for application.

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 2 DISTRICT 1 DISTRICT OFFICE SECTION

USAGE	A couple did not work properly. Most worked well Couple of calls from public - positive
VISIBILITY	Personal observation showed no problems. Easily seen day & night
MAINTENANCE	Vandalism & theft are problems
INSTALLATION	Excessive maintenance costs due to vandalism and theft our budgets cannot absorb this dollar amount. Out of state travelers did not understand
OTHER	

REGION 2 DISTRICT 1 TILLAMOOK SECTION

USAGE	Winter was too mild to make a good test. What I did hear was positive.
VISIBILITY	Not to my knowledge
MAINTENANCE	Replacement of stolen or vandalized buttons all maintenance was due to vandalism.
INSTALLATION	Signs should be larger
OTHER	

REGION 2 DISTRICT 1 WARRENTON SECTION

USAGE	Numerous comments from public. Functioned well for the most part
VISIBILITY	No problems
MAINTENANCE	Excessive theft & vandalism. Took more labor to maintain than regular delineators.
INSTALLATION	
OTHER	Public would like the buttons over the entire section

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 2 DISTRICT 3 SALEM 2201 SECTION

USAGE	Signs were confusing to some. More advance warning would help Local enforcement appreciated alerts along with others. Comments on signing - hard to understand
VISIBILITY	Have heard no comments either way. Unusually warm winter
MAINTENANCE	Only one lost to theft
INSTALLATION	Used standard sight post procedures
OTHER	

REGION 2 DISTRICT X REGION OFFICE SECTION

USAGE	Public feedback was positive
VISIBILITY	
MAINTENANCE	$2,494 spent on maintenance due to theft/vandalism
INSTALLATION	
OTHER	

REGION 3 DISTRICT 5 OAKRIDGE SECTION

USAGE	No public feedback. Inconsistency in amount of blue showing
VISIBILITY	
MAINTENANCE	High theft problem
INSTALLATION	29 units in 3/4 mile area, easy to install
OTHER	Recommend stop use due to theft, vandalism, & inconsistency

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 3 DISTRICT 7 PORT ORFORD SECTION

USAGE	Not enough freezing weather to evaluate
VISIBILITY	No problems
MAINTENANCE	ID on devices to trace & prosecute thieves make them more theft proof
INSTALLATION	Easy to install. Bridges needed post modification
OTHER	Make in smaller size - less attractive to thieves. Too big for paddle they are mounted on

REGION 3 DISTRICT 8 CENTRAL POINT SECTION

USAGE	No public comments received. Some changed faster or slower than others
VISIBILITY	No problems
MAINTENANCE	Frequent repair due to vandalism
INSTALLATION	No harder the regular sight posts
OTHER	They are broken and removed from posts - Too expensive

REGION 4 DISTRICT 11 LAKE OF THE WOODS SECTION

USAGE	Not understood at first
VISIBILITY	Very good - until snow/slush removal
MAINTENANCE	Wash after storm. Some post straightening
INSTALLATION	
OTHER	Too many are stolen. Need a better way of fastening. Warm winter did not allow real evaluation.

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 4 DISTRICT 9 WARM SPRINGS SECTION

USAGE	Public indicated that they were not in right place. Normally blue on graveyard but were changing with weather. Traveling public was interested and were looking for change
VISIBILITY	At dawn, when blue, they would show up good. At dark, they were very visible. At dawn, they were like regular sight posts
MAINTENANCE	Snow & ice would build up on them. Used deicer to remove snow & ice. Sometimes used a scraper to remove ice
INSTALLATION	
OTHER	Surface should be more rounded to reduce snow and ice buildup. Think they are great. Wish the team had more input as to location. They are an asset to the section.

REGION 4 DISTRICT 9 WARM SPRINGS W SECTION

USAGE	Seemed to work pretty good. When public noticed them the stealing started
VISIBILITY	Problems with snow & sand, surface became scratched
MAINTENANCE	
INSTALLATION	
OTHER	Lot of maintenance for a mountain pass, most were not needed. Snow on road means ice.

REGION 4 DISTRICT X REGION OFFICE SECTION

USAGE	One letter of support
VISIBILITY	
MAINTENANCE	
INSTALLATION	
OTHER	Change to larger device on sign only

COMMENT SUMMARY - ICE ALERTS® - WINTER 1991 - 92

REGION 5 DISTRICT 12 HERMISTON

USAGE	Little public feedback. 100% lost to vandalism & theft
VISIBILITY	Rising or setting sun on devices made them hard to see
MAINTENANCE	Devices needed almost daily replacement
INSTALLATION	Instructions were not clear. Some needed materials not available from storeroom
OTHER	Possible need for public awareness. Not sure of value to public

TRAFFIC SECTION

USAGE	
VISIBILITY	Dawn/dusk visibility problems. Hard to distinguish blue/white colors
MAINTENANCE	
INSTALLATION	
OTHER	Other less costly methods may be available to do the job. Possible time to look at a broader study

Appendix E

RISK MANAGEMENT AND LIABILITY CORRESPONDENCE

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DEPARTMENT OF JUSTICE
GENERAL COUNSEL DIVISION

November 2, 1994

Dick Parker
Research Unit
Engineering Services Section
2950 State Street
Department of Transportation
Salem, OR 97310

Re: Ice Alert
DOJ File No. 734-270-0095

Dear Mr. Parker:

You request a legal opinion concerning liability which could arise from the use of the device known as Ice Alert. The four letters and memos attached to the request are each excellent overviews of issues surrounding the use of this device, and they should all be considered attachments to this letter. To the extent possible, I will not reiterate specific issues addressed in those documents.

The first concern is that the device is not currently included within the Manual on Uniform Traffic Control Devices (MUTCD), does not conform to that manual's requirements, and is not being recommended by the Oregon Committee on Traffic Control Devices for inclusion within the manual. I advise that without compliance with the MUTCD the device not be erected or used by ODOT. The previous testing was apparently accomplished under demonstration or provisional testing provisions and, now that the testing has run its course, the decision must be made of whether to abandon use of the device or to make the device a part of the MUTCD.

ODOT only has authority to erect signs and devices upon highway right of way where provided such authority in the statutes. ORS 810.200 and 810.210 provide such authority for the erection of traffic control devices. Traffic control devices, as defined in ORS 801.540, include "any sign, signal marking or device placed, operated or erected by authority under ORS 810.210 for the purpose of guiding, directing, warning or regulating traffic." The MUTCD is adopted by the Oregon Transportation Commission, in part, to provide uniform standards for traffic control devices. In addition, ORS 810.210(2)(b) provides that "[a]ll traffic control devices erected and used under this subsection shall conform to the state manual and specifications established under ORS 810.200."

Therefore, I conclude that unless allowed under the MUTCD, or allowed under some exemption of the MUTCD, ODOT cannot legally erect or use the devices on state highway right of way. Erection of such devices, when contrary to the MUTCD and statutory requirements, will subject ODOT to liability exposure for damages related to their use.

Your second question relates to manufacturer representations that the device is for "information only," and not as a "warning." Therefore, there is no explicit warranty for accuracy or performance. Your third question concerns the implications of a "false-safe" or lack of indication of freezing temperature when ice is present. Both of these questions relate to performance and reliability of the device.

Hopefully the testing has given ODOT information concerning the reliability, and it can base its decision of the device's value and usefulness on that information. As discussed in the memo from Bob Nies, if the device is reliable, there will be few claims relating to providing false information. If, on the other hand the device is not reliable, then ODOT's liability risks rise.

No matter how much the manufacturer may qualify the use of the device as informational, the public will perceive it, and use it, as a warning. Even with all the additional explanatory signing possible, it is still at the very least a warning of freezing temperature with all of the attendant and resultant implications.

My general advice to ODOT is that if a sign or device is useful and is reliable, then the possibility of liability resulting from the motoring public misconstruing the information should not be the major consideration. It is an ODOT policy decision whether that risk is outweighed by the advantages. However, with traffic control devices, the devices must be allowable pursuant to the MUTCD. If not approved and included, I advise that the risk is great.

Sincerely,

Dale K. Hormann
Assistant Attorney General
Government Services Section

DKH:cfs/JGG0A978
c: Tom Lulay, Technical Services Branch, ODOT
Cam Gilmour, Program Services, ODOT

DAVE FROHNMAYER
ATTORNEY GENERAL

JAMES E. MOUNTAIN, JR.
DEPUTY ATTORNEY GENERAL

MA1 16-5

DEPARTMENT OF JUSTICE

GENERAL COUNSEL DIVISION
Justice Building
Salem, Oregon 97310
Telephone: (503) 378-4620

MEMORANDUM

DATE: May 26, 1989

TO: Dale Allen
Region 4 Engineer

FROM: Cynthia A. Carter Cindy
Assistant Attorney General
General Government Section

SUBJECT: Ice Alert Device
DOJ File No. 734-040-0089

I read with interest the information you sent on the ice alert device you propose to test in limited locations.

While I believe the device could possibly be of assistance to motorists, I feel some obligation to remind all those concerned of the potential liability exposure to the agency. When the agency places an item on state highways, the public is of the opinion (and some courts have agreed) that the agency warrants the accuracy and effectiveness of the item. In the present instance, I can envision a case of an ice-related accident in which the motorist indicates that he/she relied on the ice alert devices and therefore the state is at fault because the devices did not reflect the extent or severity of the icy conditions.

ie Permanent use on other hwys following some testing.

I recognize that I am not telling you anything new. I do recommend, however, that placement of the ice alert devices be treated as a policy decision to be presented to either Mr. Forbes or the R Team.

Agree after testing

CAC:aml/6537G

cc: Dwayne Hofstetter, Traffic Engineer
Don Forbes, State Highway Engineer

cc Nelson 5-30 MR

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Telephone: (503) 378-4620
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July 18, 1990

Dale Allen
Region 4 Engineer
Highway Division
63055 N. Highway 97
P.O. Box 5309
Bend, OR 97708

Re: Ice Alert Delineator Devices
DOJ File No. 734-040-FG069-90

Dear Mr. Allen:

You requested that I review the Highway Division's potential exposure to tort liability for the division's use of the ice alert delineator device. I am assuming you are particularly interested in liability exposure, and limitation of that exposure, during a limited duration and limited geographic area test.

Many of the potential problems exist because in order for these devices to be of any assistance drivers must be educated as to what these devices are signaling; however, once that education is accomplished, then an expectation risk is created. Drivers expect the devices to be used everywhere and adjust their thinking, reactions and driving accordingly.

I have reviewed Dwayne Hofstetter's June 22 memo to Duane Christensen, and agree with his recommendations. I have the following additional comments. I would propose that once a test area has been selected and these devices have been installed, that beginning and ending signs be developed and erected to clearly signal the start and finish of the test area. I envision a beginning sign which would have a message similar to the following: "Test Area Next ___ Miles -- Freezing Temperature -- When Delineator ___ is Blue." The ending sign would state: "End Test Area."

This type of beginning message has a multiple purpose. It does educate the driver of what this device is supposed to do. It also indicates that the device only is to reflect a freezing temperature, and not that ice exists, or even that there is a potential for ice. It also clearly, and unambiguously delineates that this is a test and that the confines of those tests is limited. This should also educate the driver that they are not to expect use of this device in other than this test area.

Mr. Hofstetter's item No. 10, in his June 22 letter, mentions legal ramifications of the use of a limited location, particularly if the white reflectors of the ice alert denote nonfreezing weather and the effect of the normal, standard white reflectors on delineators outside of the test section. I would hope that the above type of beginning and ending message should limit our exposure in this type of situation.

The types of liability issues which can probably not be as easily addressed are those where the device either does not work correctly, so that a freezing temperature is not indicated where one does exists, or where there is ice on the highway even though the device may not reflect that there is a freezing temperature. These are issues which should be examined during a test period to see if there really are problems in this area.

If the test is successful and wide-spread use of this device is being proposed, then we have the further problem of whether this device is going to be used on all stretches of highway at all times. Then the problem arises of drivers being used to the device in one area, and not finding its utilization in another. We can revisit that issue when and if wide-spread use is to occur. However, one possibility is the type of beginning and ending signs proposed by the "Ice Alert" manufacturer for certain sections of highway. Again, this will need a much more extensive driver education program if that is to occur.

Sincerely,

Dale K. Hormann

Dale K. Hormann
Assistant Attorney General
Finance and Government Section

DKH:aml/5551G

c: Dwayne Hofstetter, Traffic Engineer
Duane Christensen, Proj. Development Engineer
Bill Quinn, Materials Unit

Kes 5

Memorandum

Ice Alert

U.S. Department of Transportation
Federal Highway Administration

Subject: Request to Experiment With Warning Sign Using Temperature Sensors

Date: DEC 10 1992

From: Director, Office of Highway Safety
Washington, D.C. 20590

Reply to Attn. of: HHS-31

To: Mr. Jerald P. Clark
Regional Administrator (HEO-010.1)
Portland, Oregon

Thank you for your October 19 request from the Oregon Department of Transportation to experiment with a warning sign device that has temperature sensors for detecting freezing weather. After reviewing this request, the following comments and concerns are provided:

1. The Oregon Division Office's October 2 memorandum indicates that the proposed sensor device will be used to supplement the State's Ice Warning Sign, OW15-13. We agree that if used, the proposed sensor device should be used in conjunction with the Ice Warning Sign. However, the ICE message on the OW15-13 warning sign is incomplete and may be misleading. We recommend that you use messages such as ICE ADVISORY and BLUE - AIR TEMPERATURE BELOW FREEZING, possibly followed by the message BRIDGE DECK FREEZES BEFORE ROADWAY.

2. Since the message on the proposed warning sign may be confusing to the motorist, it is important that a motorist comprehension study be conducted. The message should in some way relate the sensors (or blue dots) to possible freezing conditions.

3. Where will the field test be conducted? A more detailed evaluation plan is needed which addresses this issue. The evaluation plan should also address concerns such as conspicuity, legibility, recognition distance, and other measures of effectiveness.

4. What color are the sensors before turning blue and what message does that color convey to the motorist? How do color blind drivers perceive the sensors? What effect does sunlight have on the sensors? How do the sensors perform under nighttime conditions? We recommend that an off-road evaluation be conducted to address these concerns before the experimental signs are installed.

5. In situations where the sensor device is used to warn of icy bridge conditions, what provisions have been made for the difference in the ambient temperature at the actual location of the sensor device and the location of the bridge, especially given that the bridge deck freezes first.

Sensors have been tried before without successful results. You cannot always depend on the reliability of temperature sensors. Because of the sensors' reliability, these signs could create a hazard and a liability issue. Your further consideration of the above items would help to make this a more viable experimentation. For recordkeeping purposes, your request has been numbered and titled "II-220(Ex) - Warning Signs Using Temperature Sensors." Your request is conditionally approved subject to receipt of the additional information recommended above.

R. Clarke Bennett

Oregon

DEPARTMENT OF
ADMINISTRATIVE
SERVICES

RISK MANAGEMENT
DIVISION

December 17, 1993

TO: DICK PARKER
PRINCIPAL INVESTIGATOR
DEPARTMENT OF TRANSPORTATION
2950 STATE STREET
SALEM OR 97310

Res 5
Dale Allen

RECEIVED
RESEARCH UNIT
DEC 20 1993

FROM: Robert Nies, Risk Management Consultant
Risk Management Division
Phone: 378-5521
Fax: 373-7337

RUE OSC P
TTC ___ TSC ___
FYI TAA FILE Return To: _____

SUBJ: ICE ALERT SIGNS

I received a copy of Dale Allen's correspondence dated December 3. At your request, I will respond through this memo.

Per **ISSUE 5** of attachment, many maintenance supervisors question the sign's accuracy. Our primary concern in the inaccuracy item is a "false-safe" indication. ODOT has potential liability if a driver has an accident because ice is present and he claims he maintained his speed since the **Ice alert sign** did not indicate ice was present. We may be hard-pressed to deny this type of claim. On the other hand, if your people consider the sign reliable, this issue would be a minor one.

There are two other important matters to mention if ODOT decides to use the signs:

1. There is a responsibility to keep them maintained.
2. Your agency should be prepared to explain how it decided where to post the signs. We advise written criteria be established at a high level. Once established, it is important the districts comply and apply the criteria uniformly across the state. Consistency in its implementation puts your agency in a much better position to defend itself. In a claim, it may be difficult for your agency to explain why a sign is posted in one area and not in another area that has similar, if not the same conditions.

RAN/Ice_12
Attachment

c: Dan Hartman, Risk & Finance Mgr.--DAS
Ron Kelm, Claims Manager--DAS
Dale Allen, Region Manager--ODOT
Dwayne Hofstetter, Traffic--ODOT
John Sheldrake, Operations--ODOT
Stan Porter, Traffic Safety--ODOT
Arlene Post, Communications--ODOT

1225 Ferry Street SE
Salem, OR 97310-1570
(503) 373-7475
FAX (503) 373-7337

Washington State Department of Transportation

Intra-Departmental Communication

Date: September 13, 1991

From: R. G. Finkle
Mats Lab/QM-21/7365

Subject: New Product Evaluation
Ice Alert(r) Device

To: R. A. Mattila, NB-82, D-1, MS-114
R. S. Spratt, D-2
D. C. Jackson, D-3, KT-11
G. L. Edwards, D-4, S-15
T. E. Lyon, D-5
R. H. Hart, D-6

Based on the review and evaluation of the Ice Alert roadway delineator by the New Product Committee, we have some major concerns over the use of this product. As part of the evaluation process, we contacted the Attorney General's Office for an opinion. Specifically, they were concerned with the liability of our use of this device which may either fail to function, thus not alerting the user to an icing condition, or may give an incorrect indication advising of a hazard where none exists. It is a temperature guidance device and not an ice indicator.

The committee has no further interest in evaluating this product due to these liability concerns, costs, placement, driver education, and lack of product warranty.

The committee stands against the use of this product for the reasons stated above. District 4 has been advised of the committee's recommendation. If they wish to continue testing the device, it should be through a planned research project to cover the liability question.

RGF:jc

cc: J. R. Buss, Operations/7350
D. K. Peach, Traffic Engr./7344
R. E. Allison, QM-21/7365

913RF2c7

RECEIVED
SEP 28 '91
Area 4

	CC	To	Initial
Supt.			
Supv. WW			
Supv. CI.			
Office			
Shop			

DEPARTMENT OF TRANSPORTATION
DISTRICT 3
MAIL ROOM
SEP 17 '91

OLYT ADMIN			MATERIALS
MAINT SVCS			TRAFF./TRANSP.
PROJ. DEV. ENGR			CONST. ASST
OPERATIONS ENG.			DEV. BR. ENGR. ENG.
ADMIN OFF			ASST MAT. MGR. ENG.
LAND MGMT Supv			PLANNING ENGR
STATE AID ENGR			UTILITIES
ASST ST AID ENGR			ENVIRONMENTAL
ASST P.E. ENGR			RIGHT-OF-WAY
ASST CONST. ENGR			BRIDGES
ASST MTCE Coord			
MAINT ANALYST			
TRAFFIC ENGR			MED SYSTEMS
EQUIP SUPV			ACCOUNTING
PERMITS			SAFETY
			SUPPLY
			SECRETARY
			FILE

cc: Gordon 9/20

DOT 700-006 (x) Rev 10/89

Appendix F

TEMPERATURE AND SPEED DATA

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	13092	1300	54.1	51.3	59.7	64.0
HAM	13092	1400	53.1	49.7	60.6	64.8
HAM	13092	1500	54.5	50.9	59.4	63.6
HAM	13092	1600	55.1	50.4	60.4	64.6
HAM	13092	1700	52.3	48.9	60.4	65.1
HAM	13092	1800	50.3	47.3	59.4	63.8
HAM	13092	1900	49.2	45.9	59.8	64.0
HAM	13092	2000	47.6	44.3	59.1	62.9
HAM	13092	2100	46.3	44.2	62.1	64.3
HAM	13092	2200	46.3	45.0	60.0	64.8
HAM	13092	2300	45.9	44.9	60.6	65.0
HAM	13092	2400	45.4	44.0	58.8	63.0
HAM	13192	100	45.8	45.1	61.1	62.8
HAM	13192	200	45.9	45.3	60.0	65.2
HAM	13192	300	45.5	45.3	59.5	64.5
HAM	13192	400	44.8	44.8	60.3	60.9
HAM	13192	500	44.2	44.9	63.7	64.2
HAM	13192	600	44.5	46.1	60.0	63.7
HAM	13192	700	45.1	46.2	60.1	64.1
HAM	13192	800	45.6	45.5	61.6	65.9
HAM	13192	900	46.0	45.2	61.4	66.0
HAM	13192	1000	48.0	49.4	59.8	64.2
HAM	13192	1100	52.4	53.8	61.1	65.0
HAM	13192	1200	56.2	57.1	60.9	65.6
HAM	13192	1300	57.6	53.7	59.7	62.8
HAM	13192	1400	57.4	49.5	59.7	64.0
HAM	13192	1500	56.4	48.3	59.5	61.7
HAM	13192	1600	53.7	47.1	60.5	64.2
HAM	13192	1700	51.9	46.7	60.5	63.9
HAM	13192	1800	49.8	44.9	57.9	62.1
HAM	13192	1900	47.8	43.7	58.3	61.5
HAM	13192	2000	46.7	42.6	59.0	62.6
HAM	13192	2100	46.0	41.3	59.2	63.3

HAM = Site on Route 58 West of Oakridge (Hampton)
SUN = Site on US 26 Near Jewel JCT. (Sunset Hwy)
WIL = Site on Wilson River Hwy 17 Miles East of Tillamook (Wilson River)
DATE = Month/Day/Year (MM/DD/YY)
TIME = Hour of Day on 24 Hour Clock
AIR TEMP. = Temperature of the Air in °F, 30 inches above the ground
PAV. TEMP. = Temperature of the Pavement Surface in °F
CNT1 = Average Speed Before the Ice Alert Section
CNT2 = Average Speed Near the End of the Ice Alert Section

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	13192	2200	45.6	41.3	58.5	61.8
HAM	13192	2300	44.7	41.1	59.4	62.6
HAM	13192	2400	45.0	41.0	57.5	62.0
HAM	20192	100	44.9	41.0	58.2	59.1
HAM	20192	200	44.7	40.9	60.0	63.7
HAM	20192	300	44.4	40.9	57.9	64.6
HAM	20192	400	44.2	40.8	56.9	62.7
HAM	20192	500	43.8	40.3	57.5	62.8
HAM	20192	600	43.5	40.1	62.5	63.5
HAM	20192	700	43.1	40.0	60.9	64.6
HAM	20192	800	42.6	40.0	57.5	64.0
HAM	20192	900	42.6	40.0	57.6	65.3
HAM	20192	1000	43.2	40.2	59.7	63.9
HAM	20192	1100	44.2	40.8	59.4	62.7
HAM	20192	1200	46.5	42.4	59.6	63.2
HAM	20192	1300	48.5	43.8	60.0	62.8
HAM	20192	1400	50.9	45.1	60.1	63.8
HAM	20192	1500	52.1	49.6	59.9	63.4
HAM	20192	1600	51.1	45.9	60.2	63.3
HAM	20192	1700	50.1	44.3	60.1	62.5
HAM	20192	1800	46.6	41.3	59.2	62.7
HAM	20192	1900	43.2	39.6	58.8	63.2
HAM	20192	2000	41.8	38.3	56.4	61.9
HAM	20192	2100	39.8	36.3	56.0	60.7
HAM	20192	2200	37.3	35.6	58.3	62.3
HAM	20192	2300	36.2	35.1	58.9	61.3
HAM	20192	2400	36.1	35.2	59.3	62.7
HAM	20392	900	32.2	33.3	56.0	64.6
HAM	20392	1000	33.3	34.5	56.0	65.2
HAM	20392	1100	35.1	36.8	55.7	64.0
HAM	20392	1200	44.2	40.2	55.0	63.6
HAM	20392	1300	50.3	45.4	55.4	64.4
HAM	20392	1400	55.3	50.8	55.9	64.5

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CNT1 = Average Speed Before the Ice Alert Section
CNT2 = Average Speed Near the End of the Ice Alert Section

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	20392	1500	55.9	51.2	54.0	62.9
HAM	20392	1600	54.2	49.2	55.1	64.0
HAM	20392	1700	50.5	46.2	55.9	64.6
HAM	20392	1800	45.4	42.4	54.2	63.1
HAM	20392	1900	42.8	39.2	55.4	64.2
HAM	20392	2000	38.6	37.1	55.3	63.8
HAM	20392	2100	36.0	34.9	55.7	63.4
HAM	20392	2200	34.7	33.7	53.8	63.2
HAM	20392	2300	33.3	33.0	56.3	62.1
HAM	20392	2400	32.3	32.8	56.6	65.6
HAM	20492	100	31.1	31.6	56.1	64.6
HAM	20492	200	30.4	31.0	57.0	64.0
HAM	20492	300	29.7	30.1	55.0	64.4
HAM	20492	400	29.0	29.8	55.0	62.8
HAM	20492	500	28.4	29.5	54.6	62.6
HAM	20492	600	28.0	29.0	56.4	64.3
HAM	20492	700	27.9	28.9	54.1	62.2
HAM	20492	800	27.7	28.8	55.0	61.4
HAM	20492	900	27.7	28.9	56.1	62.8
HAM	20492	1000	28.8	29.8	54.4	60.5
HAM	20492	1100	30.8	32.2	54.0	62.5
HAM	20492	1200	43.7	36.7	54.8	63.0
HAM	20492	1300	54.5	44.0	54.3	63.1
HAM	20492	1400	59.4	50.3	54.9	63.4
HAM	20492	1500	55.4	52.9	55.6	64.3
HAM	20492	1600	49.6	47.9	56.1	64.4
HAM	20492	1700	46.5	43.0	54.8	63.7
HAM	20492	1800	43.3	41.4	54.3	63.0
HAM	20492	1900	40.4	38.0	54.0	63.4
HAM	20492	2000	36.8	36.3	55.1	63.0
HAM	20492	2100	35.3	34.1	55.6	64.4
HAM	20492	2200	33.9	33.3	54.6	63.4
HAM	20492	2300	32.8	33.2	53.9	62.9

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PAV. TEMP. = Temperature of the Pavement Surface in °F
CNT1 = Average Speed Before the Ice Alert Section
CNT2 = Average Speed Near the End of the Ice Alert Section

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	20492	2400	32.2	33.1	56.3	63.6
HAM	20692	100	33.0	35.6	62.7	67.0
HAM	20692	200	32.9	35.4	61.5	63.0
HAM	20692	300	32.4	35.3	59.3	59.0
HAM	20692	400	32.0	34.2	62.0	64.2
HAM	20692	500	31.6	33.8	61.1	64.7
HAM	20692	600	32.3	35.4	61.3	64.9
HAM	20692	700	33.1	35.9	61.1	64.9
HAM	20692	800	33.9	36.3	60.8	65.4
HAM	20692	900	35.5	37.0	59.9	64.0
HAM	20692	1000	37.8	39.1	61.6	65.1
HAM	20692	1100	43.0	43.1	60.3	62.2
HAM	21492	1700	47.2	41.5	60.3	59.0
HAM	21492	1800	45.8	40.7	60.7	59.5
HAM	21492	1900	44.3	39.9	59.4	57.7
HAM	21492	2000	43.6	39.8	60.4	58.9
HAM	21492	2100	42.4	39.0	61.3	60.0
HAM	21492	2200	41.7	38.1	60.8	59.9
HAM	21492	2300	40.6	37.2	59.9	58.7
HAM	21492	2400	39.2	36.3	62.8	59.6
HAM	21592	100	37.4	35.7	61.6	57.9
HAM	21592	200	37.2	35.5	61.1	61.6
HAM	21592	300	36.5	34.8	62.8	56.8
HAM	21592	400	33.6	33.1	60.1	59.7
HAM	21592	500	32.6	32.2	63.3	60.0
HAM	21592	600	31.3	31.7	63.0	61.3
HAM	21592	700	30.3	31.6	63.6	59.9
HAM	21592	800	30.7	31.4	63.1	62.1
HAM	21592	900	31.6	32.2	63.8	60.1
HAM	21592	1000	32.8	33.0	65.6	57.6
HAM	21592	1100	39.3	36.2	67.0	58.5
HAM	21592	1200	52.0	41.2	66.9	58.4
HAM	21592	1300	58.3	48.1	64.9	57.7

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PAV. TEMP. = Temperature of the Pavement Surface in °F
CNT1 = Average Speed Before the Ice Alert Section
CNT2 = Average Speed Near the End of the Ice Alert Section

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	21592	1400	63.8	57.1	63.8	59.5
HAM	21592	1500	65.9	58.3	66.1	59.3
HAM	21592	1600	56.5	48.2	65.2	58.7
HAM	21592	1700	52.7	44.7	67.1	60.5
HAM	21592	1800	49.4	41.5	64.5	58.9
HAM	21592	1900	46.1	40.0	63.3	59.5
HAM	21592	2000	44.6	39.1	63.5	60.6
HAM	21592	2100	43.2	38.0	64.2	60.8
HAM	21592	2200	40.9	36.7	64.3	60.1
HAM	21592	2300	37.9	35.3	62.7	58.6
HAM	21592	2400	36.2	33.5	64.4	57.3
HAM	21892	1200	49.4	44.7	58.0	0.0
HAM	21892	1300	52.0	48.2	59.8	59.9
HAM	21892	1400	57.2	50.1	58.2	58.8
HAM	21892	1500	57.8	48.6	60.1	60.3
HAM	21892	1600	57.2	49.0	59.1	60.3
HAM	21892	1700	57.5	48.9	58.0	58.3
HAM	21892	1800	53.1	46.7	59.6	59.2
HAM	21892	1900	50.2	45.5	58.4	57.8
HAM	21892	2000	48.8	44.9	58.5	56.3
HAM	21892	2100	48.0	44.5	58.7	57.3
HAM	21892	2200	47.4	44.2	58.1	59.1
HAM	21892	2300	47.0	44.2	58.7	59.4
HAM	21892	2400	46.9	44.5	61.3	60.4
HAM	21992	100	46.9	44.7	60.0	59.8
HAM	21992	200	46.9	44.8	61.9	61.5
HAM	21992	300	46.7	44.7	58.9	60.3
HAM	21992	400	46.3	44.7	59.7	61.9
HAM	21992	500	46.1	44.6	59.4	60.4
HAM	21992	600	46.3	44.4	61.7	61.3
HAM	21992	700	46.3	44.5	60.3	60.2
HAM	21992	800	46.3	44.4	59.3	59.1
HAM	21992	900	47.0	44.8	59.7	58.6

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CNT1 = Average Speed Before the Ice Alert Section
CNT2 = Average Speed Near the End of the Ice Alert Section

SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	21992	1000	48.8	46.1	61.2	60.6
HAM	21992	1100	52.4	48.5	61.4	61.2
HAM	21992	1200	56.1	49.2	59.0	59.9
HAM	21992	1300	59.5	51.9	57.7	58.7
HAM	21992	1400	62.0	53.1	59.9	59.0
HAM	21992	1500	62.0	52.7	59.2	59.3
HAM	21992	1600	59.4	51.9	60.2	59.1
HAM	21992	1700	57.4	50.5	60.7	60.7
HAM	21992	1800	55.0	49.4	60.7	59.3
HAM	21992	1900	52.8	48.7	59.6	59.8
HAM	21992	2000	50.4	48.2	62.1	60.4
HAM	21992	2100	49.8	48.0	61.8	62.8
HAM	21992	2200	49.2	47.0	63.4	63.2
HAM	21992	2300	49.1	47.0	61.7	60.7
HAM	21992	2400	48.9	47.4	62.7	62.1
HAM	22092	100	48.5	47.3	58.6	63.9
HAM	22092	200	47.8	46.8	61.5	61.1
HAM	22092	300	48.1	46.8	61.6	60.3
HAM	22092	400	47.3	47.7	61.6	60.6
HAM	22092	500	47.6	48.9	61.7	59.7
HAM	22092	600	47.6	47.3	61.3	60.1
HAM	22092	700	47.3	45.3	61.2	61.5
HAM	22092	800	46.9	43.8	61.1	58.1
HAM	22092	900	46.4	42.6	57.8	56.5
HAM	22092	1000	46.1	41.3	62.1	59.2
HAM	22092	1100	49.1	44.0	61.5	61.3
HAM	22092	1200	51.4	45.0	60.9	59.9
HAM	22092	1300	53.7	45.9	60.9	58.4
HAM	22092	1400	55.5	46.3	60.7	61.1
HAM	22092	1500	55.9	46.9	59.9	57.8
HAM	22092	1600	56.1	47.5	59.3	59.6
HAM	22092	1700	54.8	47.0	58.1	58.9
HAM	22092	1800	53.2	46.4	61.4	61.9

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	22092	1900	50.0	44.6	60.6	61.0
HAM	22092	2000	47.4	43.3	60.8	62.0
HAM	22092	2100	46.9	42.4	61.9	60.0
HAM	22092	2200	45.8	41.0	59.6	58.8
HAM	22092	2300	44.4	40.8	61.5	60.0
HAM	22092	2400	45.0	41.9	62.6	61.8
HAM	22192	1700	60.1	53.1	60.4	59.6
HAM	22192	1800	57.5	51.4	61.1	60.2
HAM	22192	1900	53.4	49.0	60.0	59.8
HAM	22192	2000	49.5	46.4	60.7	59.9
HAM	22192	2100	47.7	45.2	59.5	59.1
HAM	22192	2200	46.7	44.1	61.6	61.1
HAM	22192	2300	46.1	43.8	58.9	60.1
HAM	22192	2400	46.0	43.8	59.4	59.2
HAM	22392	100	40.1	38.9	58.3	60.3
HAM	22392	200	38.8	38.4	57.0	55.9
HAM	22392	300	38.4	38.3	59.2	62.0
HAM	22392	400	38.2	38.1	56.8	59.1
HAM	22392	500	38.3	37.9	62.9	57.5
HAM	22392	600	38.1	37.7	59.3	62.1
HAM	22392	700	37.6	37.2	61.2	62.1
HAM	22392	800	38.3	37.4	60.0	61.3
HAM	22392	900	40.3	38.8	58.9	60.5
HAM	22392	1000	43.2	41.4	60.6	60.5
HAM	22392	1100	49.2	45.1	60.9	61.0
HAM	22392	1200	57.0	48.8	61.2	60.4
HAM	22392	1300	67.0	56.4	61.5	61.1
HAM	22392	1400	70.0	58.1	59.9	60.3
HAM	22392	1500	68.7	57.9	62.1	61.8
HAM	22392	1600	67.0	56.3	61.4	61.0
HAM	22392	1700	63.7	53.7	60.1	61.0
HAM	22392	1800	60.8	50.9	60.6	59.2
HAM	22392	1900	57.1	49.0	55.3	59.3

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	22492	1000	47.4	46.1	58.3	57.5
HAM	22492	1100	56.7	50.3	60.2	60.7
HAM	22492	1200	68.1	55.0	59.5	59.2
HAM	22492	1300	80.5	63.5	57.7	59.9
HAM	22492	1400	85.2	68.6	59.5	60.4
HAM	22492	1500	84.9	68.2	60.1	60.6
HAM	22492	1600	73.4	57.2	60.2	60.1
HAM	22492	1700	66.1	54.3	59.9	59.3
HAM	22492	1800	61.5	51.5	57.7	59.3
HAM	22492	1900	57.1	48.6	59.1	59.0
HAM	22492	2000	54.3	46.5	59.7	59.8
HAM	22492	2100	50.9	45.1	61.0	60.8
HAM	22492	2200	49.5	44.2	59.3	59.1
HAM	22492	2300	48.0	43.6	60.8	60.4
HAM	22492	2400	46.6	43.2	61.8	62.8
HAM	22592	100	46.1	44.1	59.6	60.0
HAM	22592	200	46.0	44.3	59.6	61.2
HAM	22592	300	45.7	44.1	57.7	59.0
HAM	22592	400	45.3	44.1	60.0	61.3
HAM	22592	500	45.0	44.0	60.6	60.2
HAM	22592	600	44.8	43.8	60.6	61.4
HAM	22592	700	44.1	43.3	60.1	61.2
HAM	22592	800	43.3	42.5	60.5	62.0
HAM	22592	900	44.7	43.8	59.9	60.7
HAM	22592	1000	46.0	45.1	59.3	59.7
HAM	22592	1100	57.5	51.8	61.0	60.4
HAM	22592	1200	70.3	57.9	60.4	61.5
HAM	22592	1300	77.0	62.9	58.8	60.0
HAM	22592	1400	85.4	70.6	58.5	59.1
HAM	22592	1500	83.6	68.6	58.7	59.3
HAM	22592	1600	72.4	59.3	59.2	58.8
HAM	22592	1700	66.0	57.5	59.9	59.2
HAM	22592	1800	62.3	55.3	60.3	60.1

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	22592	1900	58.4	50.5	60.1	59.6
HAM	22592	2000	54.1	48.1	59.6	60.0
HAM	22592	2100	50.9	46.2	58.2	58.4
HAM	22592	2200	49.4	45.1	59.0	60.5
HAM	22592	2300	47.4	44.1	61.3	60.5
HAM	22592	2400	46.6	43.6	61.4	61.1
HAM	22692	100	45.6	43.0	60.8	60.6
HAM	22692	200	44.4	42.4	59.2	57.9
HAM	22692	300	43.9	41.8	60.8	59.8
HAM	22692	400	43.2	41.4	62.4	61.5
HAM	22692	500	42.4	41.0	59.2	58.1
HAM	22692	600	42.3	41.3	61.0	60.6
HAM	22692	700	42.4	41.9	59.9	59.7
HAM	22692	800	43.0	42.8	61.7	59.7
HAM	22692	900	44.7	45.9	61.6	58.3
HAM	22692	1000	47.5	48.4	61.9	58.7
HAM	22692	1100	59.3	55.5	59.8	57.0
HAM	22692	1200	68.8	60.8	60.6	58.4
HAM	22692	1300	84.4	67.3	61.0	59.4
HAM	22692	1400	87.6	72.4	60.5	60.1
HAM	22692	1500	85.5	67.5	62.1	60.2
HAM	22692	1600	73.3	62.8	61.5	60.2
HAM	22692	1700	67.9	59.4	60.9	59.3
HAM	22692	1800	62.7	54.4	62.2	59.8
HAM	22692	1900	57.9	50.4	61.7	59.9
HAM	22692	2000	55.0	48.3	63.5	59.8
HAM	22692	2100	51.7	46.4	63.0	58.7
HAM	22692	2200	49.7	45.2	62.4	60.0
HAM	22692	2300	48.2	44.3	64.0	60.0
HAM	22692	2400	46.8	43.9	64.2	60.8
HAM	22792	100	46.2	44.0	62.9	60.5
HAM	22792	200	45.9	44.8	63.9	62.1
HAM	22792	300	45.5	44.8	61.8	61.4

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
HAM	22792	400	45.0	45.0	62.5	59.0
HAM	22792	500	44.7	45.0	63.4	61.2
HAM	22792	600	44.1	44.6	64.4	62.5
HAM	22792	700	43.5	44.1	64.6	60.5
HAM	22792	800	43.3	43.6	66.2	60.9
HAM	22792	900	44.1	44.6	66.1	60.6
HAM	22792	1000	46.2	46.5	66.8	61.1
HAM	22792	1100	58.5	54.9	65.4	59.3
HAM	22792	1200	74.5	59.2	66.7	61.2
HAM	22792	1300	81.2	67.0	66.3	60.1
HAM	22792	1400	86.2	71.5	67.4	60.3
HAM	22792	1500	83.8	69.3	68.1	60.5
HAM	22792	1600	78.2	62.3	68.3	59.9
HAM	22792	1700	66.1	57.9	68.7	59.5
HAM	22792	1800	63.8	54.3	73.2	60.3
HAM	22792	1900	58.6	51.2	72.5	59.6
HAM	22792	2000	54.4	47.2	70.8	60.5
HAM	22792	2100	50.9	45.1	71.4	61.4
HAM	22792	2200	48.5	43.4	70.7	59.7
HAM	22792	2300	46.9	41.8	72.3	59.6
SUN	13192	300	48.0	51.0	53.9	54.3
SUN	13192	400	48.0	50.0	54.2	54.1
SUN	13192	500	48.0	51.0	54.2	54.3
SUN	13192	600	48.0	50.0	54.3	54.0
SUN	13192	700	48.0	50.0	53.1	53.5
SUN	13192	800	48.0	51.0	53.5	54.0
SUN	13192	900	49.0	52.0	53.9	53.9
SUN	13192	1000	49.0	54.0	52.8	54.1
SUN	13192	1100	63.0	80.0	53.3	54.3
SUN	13192	1200	49.0	50.0	53.7	53.4
SUN	13192	1300	49.0	49.0	51.7	51.8
SUN	20192	100	47.0	45.0	53.6	54.0
SUN	20192	200	47.0	45.0	53.7	53.9

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
SUN	20192	300	49.0	48.0	53.8	54.1
SUN	20192	400	49.0	48.0	53.6	54.2
SUN	20192	500	49.0	48.0	54.3	53.1
SUN	20192	600	49.0	48.0	54.0	52.5
SUN	20192	700	49.0	48.0	53.9	51.0
SUN	20192	800	49.0	48.0	53.2	53.0
SUN	20192	900	49.0	48.0	54.1	53.9
SUN	20192	1000	45.0	48.0	54.2	54.3
SUN	20192	1100	45.0	46.0	53.9	54.0
SUN	20192	1200	45.0	45.0	54.1	54.5
SUN	20192	1300	45.0	45.0	54.2	54.1
SUN	20192	1400	45.0	45.0	53.8	54.2
SUN	20192	1500	45.0	45.0	54.1	54.0
SUN	20192	1600	45.0	45.0	53.6	53.8
SUN	20192	1700	45.0	45.0	54.2	54.2
SUN	20192	1800	45.0	45.0	54.1	54.1
SUN	20192	1900	44.0	45.0	54.1	54.1
SUN	20192	2000	44.0	45.0	53.6	54.1
SUN	20192	2100	44.0	45.0	53.0	53.5
SUN	20192	2200	44.0	45.0	53.0	54.0
SUN	20192	2300	46.0	45.0	52.8	53.7
SUN	20192	2400	47.0	45.0	51.6	51.9
SUN	20292	100	48.0	49.0	54.4	54.5
SUN	20292	200	48.0	49.0	54.7	54.4
SUN	20292	300	47.0	45.0	53.5	53.4
SUN	20292	400	45.0	45.0	54.1	53.8
SUN	20292	500	43.0	44.0	54.5	53.2
SUN	20292	600	43.0	42.0	55.0	55.0
SUN	20292	700	43.0	42.0	51.7	54.2
SUN	20292	800	43.0	42.0	53.0	54.1
SUN	20292	900	43.0	42.0	52.1	53.2
SUN	20292	1000	43.0	42.0	52.8	53.1
SUN	20292	1100	41.0	41.0	53.6	53.8

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
SUN	20292	1200	41.0	41.0	53.7	53.7
SUN	20292	1300	41.0	41.0	54.0	53.9
SUN	20292	1400	41.0	41.0	53.9	54.4
SUN	20292	1500	41.0	41.0	53.9	54.3
SUN	20292	1600	41.0	41.0	53.5	54.1
SUN	20292	1700	41.0	41.0	53.8	53.9
SUN	20292	1800	41.0	41.0	53.4	54.1
SUN	20292	1900	41.0	41.0	53.0	54.5
SUN	20292	2000	42.0	42.0	53.4	54.7
SUN	20292	2100	43.0	42.0	52.8	53.9
SUN	20292	2200	43.0	43.0	53.0	54.6
SUN	20292	2300	43.0	45.0	52.1	54.6
SUN	20292	2400	46.0	47.0	53.6	54.4
SUN	20392	100	41.0	46.0	53.5	54.6
SUN	20392	200	42.0	50.0	54.6	54.5
SUN	20392	300	48.0	49.0	53.6	54.5
SUN	20392	400	48.0	49.0	53.6	52.5
SUN	20392	500	48.0	49.0	52.5	50.0
SUN	20392	600	48.0	49.0	55.0	48.3
SUN	20392	700	48.0	49.0	55.0	53.3
SUN	20392	800	48.0	49.0	53.4	53.9
SUN	20392	900	48.0	49.0	52.9	54.0
SUN	20392	1000	45.0	49.0	53.1	54.0
SUN	20392	1100	44.0	44.0	54.0	54.1
SUN	20392	1200	41.0	42.0	53.9	54.3
SUN	20392	1300	41.0	42.0	53.4	54.0
SUN	20392	1400	41.0	42.0	54.2	54.2
SUN	20392	1500	41.0	42.0	54.2	54.3
SUN	20392	1600	41.0	42.0	54.3	54.2
SUN	20392	1700	41.0	38.0	53.3	54.0
SUN	20392	1800	41.0	38.0	54.1	54.4
SUN	20392	1900	41.0	38.0	52.8	54.2
SUN	20392	2000	39.0	38.0	52.1	54.2

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SUN	20392	2100	39.0	38.0	51.0	53.6
SUN	20392	2200	39.0	38.0	52.8	54.6
SUN	20392	2300	39.0	38.0	53.6	54.0
SUN	20392	2400	39.0	38.0	53.1	54.4
SUN	20492	100	40.0	46.0	54.8	54.8
SUN	20492	200	40.0	46.0	54.6	55.0
SUN	20492	300	42.0	51.0	54.4	55.0
SUN	20492	400	42.0	51.0	54.0	54.0
SUN	20492	500	42.0	51.0	54.4	54.4
SUN	20492	600	42.0	51.0	55.0	50.0
SUN	20492	700	42.0	51.0	55.0	50.0
SUN	20492	800	42.0	48.0	52.6	52.4
SUN	20492	900	42.0	37.0	53.4	52.8
SUN	20492	1000	42.0	37.0	52.9	52.9
SUN	20492	1100	38.0	37.0	53.7	53.9
SUN	20492	1200	36.0	37.0	53.6	53.7
SUN	20492	1300	36.0	37.0	53.9	53.7
SUN	20492	1400	35.0	37.0	53.9	53.7
SUN	20492	1500	35.0	37.0	54.3	54.2
SUN	20492	1600	34.0	37.0	54.0	54.1
SUN	20492	1700	34.0	37.0	53.1	54.0
SUN	20492	1800	33.0	34.0	53.4	54.6
SUN	20492	1900	32.0	32.0	53.1	54.6
SUN	20492	2000	32.0	32.0	53.3	54.2
SUN	20492	2100	32.0	32.0	53.0	54.3
SUN	20492	2200	34.0	32.0	51.8	54.6
SUN	20492	2300	36.0	32.0	52.9	54.2
SUN	20492	2400	38.0	40.0	52.2	54.0
SUN	20592	100	39.0	40.0	53.7	53.4
SUN	20592	200	39.0	41.0	55.0	54.1
SUN	20592	300	40.0	46.0	53.9	53.8
SUN	20592	400	40.0	46.0	54.2	55.0
SUN	20592	500	40.0	46.0	48.8	53.3

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SUN	20592	600	40.0	46.0	51.7	50.0
SUN	20592	700	40.0	46.0	45.0	51.0
SUN	20592	800	40.0	46.0	53.2	52.8
SUN	20592	900	40.0	46.0	51.5	52.7
SUN	20592	1000	36.0	40.0	53.6	52.5
SUN	20592	1100	35.0	34.0	53.2	53.3
SUN	20592	1200	35.0	34.0	53.5	53.3
SUN	20592	1300	35.0	34.0	53.8	53.3
SUN	20592	1400	35.0	34.0	53.4	53.4
SUN	20592	1500	35.0	34.0	53.6	53.9
SUN	20592	1600	35.0	33.0	54.5	54.0
SUN	20592	1700	35.0	32.0	53.5	54.2
SUN	20592	1800	35.0	32.0	53.9	53.8
SUN	20592	1900	35.0	32.0	54.0	54.7
SUN	20592	2000	35.0	32.0	54.1	54.1
SUN	20592	2100	35.0	32.0	53.0	54.4
SUN	20592	2200	35.0	32.0	51.4	53.8
SUN	20592	2300	35.0	32.0	53.4	53.4
SUN	20592	2400	39.0	32.0	53.2	54.8
SUN	20692	1400	39.0	42.0	53.8	51.9
SUN	20692	1500	39.0	46.0	51.0	48.8
SUN	20692	1600	39.0	46.0	55.0	54.0
SUN	20692	1700	39.0	46.0	48.3	51.7
SUN	20692	1800	39.0	44.0	52.1	50.6
SUN	20692	1900	39.0	39.0	50.3	51.8
SUN	20692	2000	39.0	37.0	51.3	51.1
SUN	20692	2100	35.0	36.0	52.1	52.5
SUN	21192	1300	51.9	56.6	58.5	58.1
SUN	21192	1400	52.2	57.1	56.8	59.4
SUN	21192	1500	52.4	57.3	58.7	59.1
SUN	21192	1600	52.0	57.1	59.1	60.4
SUN	21192	1700	50.5	54.2	58.5	60.3
SUN	21192	1800	48.9	52.5	56.1	60.3

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
SUN	21192	1900	47.8	48.2	56.1	59.6
SUN	21192	2000	46.1	47.1	56.4	58.6
SUN	21192	2100	44.5	45.4	53.3	57.9
SUN	21192	2200	43.1	43.7	54.0	59.3
SUN	21192	2300	41.9	42.2	61.0	60.0
SUN	21192	2400	40.8	40.9	60.7	56.7
SUN	21292	100	40.2	39.8	60.0	52.5
SUN	21292	200	40.0	39.3	61.0	59.0
SUN	21292	300	39.7	39.1	61.7	62.5
SUN	21292	400	39.8	40.1	55.0	63.0
SUN	21292	500	39.9	40.7	60.0	61.7
SUN	21292	600	40.1	41.4	56.4	57.7
SUN	21292	700	40.4	41.7	54.4	61.2
SUN	21292	800	40.8	42.4	55.9	58.4
SUN	21292	900	41.8	43.9	58.1	58.8
SUN	21292	1000	43.5	45.3	60.1	60.3
SUN	21292	1100	47.0	48.8	58.3	59.5
SUN	21292	1200	49.1	52.2	58.4	59.1
SUN	21292	1300	50.8	53.9	59.0	60.4
SUN	21292	1400	51.0	54.8	59.1	59.2
SUN	21292	1500	51.1	55.0	59.3	60.4
SUN	21292	1600	50.4	54.2	58.5	59.1
SUN	21292	1700	49.1	53.1	59.3	60.9
SUN	21292	1800	47.6	50.9	59.7	60.5
SUN	21292	1900	45.3	48.3	57.1	59.8
SUN	21292	2000	44.3	46.1	58.7	59.5
SUN	21292	2100	44.0	44.8	59.2	61.7
SUN	21292	2200	44.0	44.9	60.5	61.9
SUN	21292	2300	44.0	44.8	58.3	58.6
SUN	21292	2400	44.0	44.6	58.2	57.3
SUN	21392	100	43.9	44.3	59.5	60.0
SUN	21392	200	43.8	44.0	53.5	51.4
SUN	21392	300	43.7	43.9	45.0	40.0

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
SUN	21392	400	43.7	44.1	50.0	50.0
SUN	21392	500	43.7	44.1	58.8	56.5
SUN	21392	600	43.5	43.8	57.0	51.7
SUN	21392	700	43.4	43.8	58.1	57.7
SUN	21392	800	43.3	43.3	55.5	58.7
SUN	21392	900	43.8	43.7	57.4	58.9
SUN	21392	1000	45.2	45.1	58.2	59.6
SUN	21392	1100	47.4	46.9	58.2	59.3
SUN	21392	1200	50.2	49.8	59.0	59.4
SUN	21392	1300	50.9	50.6	57.6	59.9
SUN	21392	1400	50.1	50.4	58.6	59.5
SUN	21392	1500	51.6	51.0	57.1	59.5
SUN	21392	1600	50.6	50.2	57.6	59.4
SUN	21392	1700	49.5	49.5	59.8	61.1
SUN	21392	1800	48.2	48.1	57.8	59.8
SUN	21392	1900	47.1	47.1	56.4	57.8
SUN	21392	2000	46.1	46.7	57.2	59.2
SUN	21392	2100	45.6	46.3	58.0	59.4
SUN	21392	2200	45.4	46.1	60.3	60.3
SUN	21392	2300	44.9	45.5	58.3	59.2
SUN	21392	2400	44.3	44.6	61.4	56.9
SUN	21492	100	43.9	43.8	62.3	61.5
SUN	21492	200	43.4	43.4	58.8	60.0
SUN	21492	300	42.9	43.1	53.3	50.0
SUN	21492	400	42.6	43.0	52.5	58.3
SUN	21492	500	42.5	43.0	58.6	57.1
SUN	21492	600	42.2	42.7	58.5	56.7
SUN	21492	700	41.3	42.2	57.1	59.4
SUN	21492	800	41.5	42.5	57.5	59.6
SUN	21492	900	42.6	44.0	54.8	59.8
SUN	21492	1000	44.3	46.9	59.3	58.9
SUN	21492	1100	45.7	49.1	57.9	58.8
SUN	21492	1200	46.6	50.1	59.6	59.6

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
SUN	21492	1300	47.4	50.5	59.4	59.8
SUN	21492	1400	48.9	52.3	58.3	59.6
SUN	21492	1500	49.6	53.0	59.1	60.0
SUN	21492	1600	49.0	50.5	59.5	59.7
SUN	21492	1700	47.4	47.4	59.3	60.1
SUN	21492	2200	42.3	41.9	58.3	40.0
SUN	21592	1100	42.6	40.2	59.0	40.0
SUN	21592	1200	42.4	44.1	58.7	20.0
SUN	21592	1300	43.9	48.1	58.7	30.0
SUN	21592	1400	45.6	50.5	58.4	30.0
WIL	21192	1700	57.1	51.2	59.7	60.7
WIL	21192	1800	56.1	49.4	60.1	60.6
WIL	21192	1900	54.6	47.0	58.4	59.5
WIL	21192	2000	52.6	46.0	59.7	58.9
WIL	21192	2100	51.6	44.2	56.9	58.1
WIL	21192	2200	50.1	43.9	58.6	60.0
WIL	21192	2300	49.5	43.2	55.8	60.0
WIL	21192	2400	48.4	42.4	58.6	58.6
WIL	21292	100	47.3	41.0	60.0	64.0
WIL	21292	200	46.0	40.5	55.0	51.3
WIL	21292	300	45.8	40.0	56.7	57.5
WIL	21292	400	45.7	40.1	60.0	62.5
WIL	21292	500	45.6	40.2	59.3	60.8
WIL	21292	600	46.4	41.1	58.9	60.2
WIL	21292	700	46.6	41.4	60.4	61.4
WIL	21292	800	47.1	41.6	59.2	61.2
WIL	21292	900	48.1	42.3	59.6	60.1
WIL	21292	1000	48.9	43.9	59.8	60.3
WIL	21292	1100	52.4	44.8	59.2	60.7
WIL	21292	1200	54.8	47.4	59.0	60.9
WIL	21292	1300	58.5	51.0	59.8	60.1
WIL	21292	1400	59.5	52.2	58.9	59.9
WIL	21292	1500	60.1	53.6	59.4	61.1

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
WIL	21292	1600	59.6	52.7	58.6	59.9
WIL	21292	1700	56.7	50.5	59.7	60.6
WIL	21292	1800	55.5	47.9	60.0	60.0
WIL	21292	1900	52.2	45.3	59.7	61.2
WIL	21292	2000	51.5	44.5	58.4	60.8
WIL	21292	2100	51.6	44.5	57.1	58.1
WIL	21292	2200	51.6	44.5	56.4	58.3
WIL	21292	2300	51.4	44.5	56.7	59.1
WIL	21292	2400	51.4	44.6	57.1	58.6
WIL	21392	100	51.3	44.6	57.5	56.0
WIL	21392	200	51.2	44.4	46.7	53.3
WIL	21392	300	51.1	44.3	57.5	58.1
WIL	21392	400	50.9	44.2	58.3	60.8
WIL	21392	500	50.8	44.1	58.2	58.4
WIL	21392	600	50.6	44.0	57.6	59.8
WIL	21392	700	50.3	44.0	57.4	58.8
WIL	21392	800	50.0	43.5	58.0	59.4
WIL	21392	900	50.4	43.5	59.5	61.0
WIL	21392	1000	51.1	45.1	59.6	60.9
WIL	21392	1100	54.3	45.6	59.7	60.6
WIL	21392	1200	55.5	47.5	59.6	60.4
WIL	21392	1300	57.3	48.6	59.8	60.6
WIL	21392	1400	57.3	48.4	58.6	60.0
WIL	21392	1500	57.8	48.2	59.8	60.8
WIL	21392	1600	58.2	47.5	59.3	60.2
WIL	21392	1700	57.2	47.4	58.6	60.8
WIL	21392	1800	55.9	46.6	58.6	59.8
WIL	21392	1900	54.3	46.3	58.1	58.4
WIL	21392	2000	53.6	45.7	60.0	60.0
WIL	21392	2100	53.0	45.3	56.8	57.0
WIL	21392	2200	52.4	44.8	57.6	57.2
WIL	21392	2300	51.8	44.4	58.5	58.8
WIL	21992	100	51.4	44.9	65.0	58.3

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
WIL	22092	100	49.7	42.8	65.0	59.4
WIL	22092	200	51.2	44.9	62.5	59.2
WIL	22092	300	51.2	44.9	63.8	55.0
WIL	22092	400	51.2	45.0	65.0	60.6
WIL	22092	500	51.2	45.2	65.0	61.2
WIL	22092	600	51.1	45.2	64.1	59.3
WIL	22092	700	51.5	45.2	64.8	59.2
WIL	22092	800	51.7	45.9	65.0	60.7
WIL	22092	900	52.8	46.2	64.8	59.9
WIL	22092	1000	53.9	47.1	64.6	60.7
WIL	22092	1100	54.1	46.4	65.0	61.3
WIL	22092	1200	53.7	45.3	63.5	58.9
WIL	22092	1300	53.2	44.8	64.5	59.9
WIL	22092	1400	52.7	44.4	64.9	60.9
WIL	22092	1500	52.7	44.6	65.0	61.3
WIL	22092	1600	53.6	44.9	64.2	59.6
WIL	22092	1700	52.5	44.4	64.9	61.2
WIL	22092	1800	52.0	43.7	65.0	60.9
WIL	22092	1900	50.9	43.6	64.8	60.7
WIL	22092	2000	50.5	43.1	64.7	60.7
WIL	22092	2100	50.1	43.0	65.0	61.1
WIL	22092	2200	49.8	42.7	65.0	57.5
WIL	22092	2300	49.7	42.8	65.0	54.2
WIL	22092	2400	49.8	42.8	65.0	59.0
WIL	22192	100	54.2	47.0	65.0	61.7
WIL	22192	200	49.6	42.8	65.0	56.3
WIL	22192	300	49.7	42.9	60.0	58.3
WIL	22192	400	49.7	43.1	65.0	59.3
WIL	22192	500	50.0	43.3	65.0	60.0
WIL	22192	600	50.3	43.8	64.4	57.7
WIL	22192	700	50.7	44.3	64.7	59.5
WIL	22192	800	53.1	47.8	64.9	61.0
WIL	22192	900	54.5	49.6	64.8	61.1

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
WIL	22192	1000	57.0	50.3	65.0	61.0
WIL	22192	1100	58.5	51.4	64.5	60.5
WIL	22192	1200	60.1	52.9	64.9	61.6
WIL	22192	1300	60.2	53.4	65.0	60.8
WIL	22192	1400	60.4	52.0	64.6	60.3
WIL	22192	1500	60.0	50.5	64.8	61.0
WIL	22192	1600	59.8	50.6	64.4	60.3
WIL	22192	1700	58.9	50.9	65.0	61.2
WIL	22192	1800	57.5	50.7	64.8	60.6
WIL	22192	1900	56.7	48.8	64.5	59.8
WIL	22192	2000	56.2	48.4	64.4	60.7
WIL	22192	2100	55.9	48.0	65.0	58.2
WIL	22192	2200	55.4	47.7	65.0	60.4
WIL	22192	2300	55.0	47.1	64.6	60.0
WIL	22192	2400	54.3	47.0	65.0	61.7
WIL	22292	100	48.5	40.2	64.2	61.7
WIL	22292	200	54.2	47.2	57.5	55.0
WIL	22292	300	54.2	47.2	62.0	59.0
WIL	22292	400	54.2	47.6	65.0	62.0
WIL	22292	500	54.3	47.5	65.0	60.0
WIL	22292	600	54.2	47.2	64.4	61.0
WIL	22292	700	54.0	46.8	65.0	60.3
WIL	22292	800	53.9	46.2	65.0	61.4
WIL	22292	900	53.9	46.0	65.0	60.8
WIL	22292	1000	55.3	46.0	64.0	60.1
WIL	22292	1100	56.4	46.0	65.0	61.0
WIL	22292	1200	58.6	47.0	65.0	60.3
WIL	22292	1300	59.0	47.0	64.6	60.2
WIL	22292	1400	59.9	47.1	64.9	61.5
WIL	22292	1500	59.5	47.2	64.8	60.7
WIL	22292	1600	59.3	47.4	64.4	60.6
WIL	22292	1700	58.1	47.6	65.0	61.1
WIL	22292	1800	55.8	47.0	64.2	59.7

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SITE	DATE	TIME	AIR TEMP.	PAV. TEMP.	SPEED CNT1	SPEED CNT2
WIL	22292	1900	51.9	43.4	64.9	60.4
WIL	22292	2000	51.5	42.1	64.6	60.4
WIL	22292	2100	50.3	41.9	64.5	61.3
WIL	22292	2200	50.0	41.8	65.0	60.9
WIL	22292	2300	49.1	41.3	65.0	60.3
WIL	22292	2400	49.0	41.1	64.5	60.5
WIL	22392	200	46.7	40.0	65.0	60.6
WIL	22392	300	46.8	39.4	64.2	60.5
WIL	22392	400	47.1	39.8	65.0	60.0
WIL	22392	500	47.4	40.2	65.0	62.5
WIL	22392	600	47.6	40.6	65.0	61.9
WIL	22392	700	47.9	40.7	65.0	59.4
WIL	22392	800	48.0	41.6	65.0	59.6
WIL	22392	900	49.6	42.0	65.0	61.2
WIL	22392	1000	51.1	45.0	64.9	60.7
WIL	22392	1100	54.8	47.3	65.0	61.0
WIL	22392	1200	58.3	50.6	64.9	60.6
WIL	22392	1300	58.9	50.8	65.0	60.7
WIL	22392	1400	59.0	50.2	65.0	60.2
WIL	22392	1500	59.3	50.4	64.7	60.4
WIL	22392	1600	59.6	50.9	65.0	60.4
WIL	22392	1700	59.5	50.8	64.9	60.0
WIL	22392	1800	57.9	49.6	64.6	60.3
WIL	22392	1900	56.5	48.6	64.6	60.2
WIL	22392	2000	56.1	47.4	65.0	60.9
WIL	22392	2100	54.8	47.0	64.9	59.9
WIL	22392	2200	54.7	46.8	64.3	59.6
WIL	22392	2300	54.1	46.6	63.9	59.3
WIL	22392	2400	54.1	46.2	63.3	55.0

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